YUKON AGRICULTURE RESEARCH AND DEMONSTRATION

2007 PROGRESS REPORT

Yukon
Energy, Mines and Resources

Executive Summary

A number of research and demonstration projects were conducted in 2007 which included two new trials, climate monitoring and continuation of research and demonstration projects from previous years. One of the new projects for 2007 evaluated carrot varieties and economics of carrot production. The carrot trial was one of the highlights from 2007, as results showed good yields and the economics of both a small and large scale operation in the Yukon generated a profit. The other new trial was a potato evaluation which looked at seeding depth, fertilizer application and a comparison of two popular red varieties of potatoes. The potato trial did not show any benefit in seeding shallow or splitting the fertilizer application. The Red Pontiac potato variety did show a marked increase in production compared to the Norland potato.

The yearly assessment of the climate and the agroclimatic capability was conducted for 2007. The central Yukon experienced an exceptionally warm and long growing season reaching an agroclimatic classification of Class 1, meaning no significant limitations on production of the full range of common Canadian agricultural crops. Although this was not the first time the central Yukon reached class 1 agroclimatic classification, it prompted further investigation into the growing season over the past ten year in the 4 main agricultural areas of the Yukon.

Soil temperature monitoring in the plough layer was monitored for the 2007 season in the Whitehorse area. Results show that soil temperatures remain relatively cool during the season limiting germination, micro organism activity and nutrient uptake. A better understanding of the soil temperatures can help the producer determine their management techniques and responses of the land to seeding, fertilizing and spraying.

An alfalfa experiment was initiated in 2005 to assess the longevity of alfalfa over time with late season harvest. The 2007 results continue to show that a late season harvest or graze significantly affects the ability of the plant to overwinter, reducing yields in next year's production.

A forage demonstration is ongoing at the Agriculture Branch research farm. A variety of forage species have been planted and yearly assessments of winter survival and biomass yields continue to be recorded.

The biodiesel oilseed evaluation was continued into its second year and the results continue to show that oilseeds can be grown north of 60°. *Camelina sativa* was the best producing of the oilseeds with yields similar to those achieved in the rest of Canada and with oil level similar to canola. The yields for the other oilseeds evaluated were below normal, and require further evaluation as a late harvest resulted in yield losses due to shattering and lodging even though the seed harvested showed poor maturity.

The raspberry orchard assessment evaluated input management and the economics of production. With a record harvest for 2007 the economics of production may be profitable if the Yukon grown product could fetch a premium price with production expenses closer to those recommended by the B.C. Ministry of Agriculture. Results also showed that the Kiska variety is a better producer and the reduced fertilizer treatment resulted in higher yields. For a portion of the season a portable green-house or row cover was added to 2 sections of the orchard, which resulted in increased production.

Preface

This document is a record of agricultural demonstration, experiments, and studies conducted in the Yukon. This is a yearly testimony of new and accumulated data and information set out to assist growers and researchers with future endeavours related to northern agriculture.

The target audience for this document is commercial agriculture producers, growers, and those interested in northern agronomic research.

Acknowledgments

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Introduction

The Yukon Agriculture Branch conducts a variety of research and demonstration work to enhance the knowledge base of agriculture north of 60°. Agriculture research has been taking place in the Yukon for almost one-hundred years and is an important aspect of the development of the industry.

As thousands of people entered the Yukon during the Klondike Gold Rush there was a necessity for people to produce their own food. In 1915, the Dominion Department of Agriculture began conducting co-operative research with interested producers in the Yukon. In 1917, the Department established an experimental sub-station at Swede Creek near Dawson City. The results of the research carried out at the station confirmed that a variety of crops could be grown successfully at a latitude of 64° north, with yields and quality of produce comparing favourably with those obtained in agricultural areas a thousand miles to the south. The Swede Creek station closed in 1925.

In 1944, after the completion of the Alaska Highway, the Government of Canada conducted soil surveys in the Yukon and established a new experimental farm at Mile 1019 of the Alaska Highway near Haines Junction. A variety of vegetables and forages were grown without difficulty, along with the raising of livestock. The station closed in 1968.

Key studies were undertaken in the 1970s to determine the climate classification and soil capability. A large scale soil mapping exercise was completed in 1977.

The Yukon Government began conducting it's own research through the 1980s. A number of studies and reports were published through the 80s and 90s examining fertilizer rates, soil organisms, forage varieties and management techniques. In 1988 the Yukon Government established a small research site at the Gunnar Nilsson and Mickey Lammers Research Forest. Over the years the site has continued variety assessments along with evaluations of soil conservation techniques, soil enrichment practices, and irrigation optimization. Today the research and demonstrations continue in the following key areas:

- Variety evaluation & demonstration
- Soil enhancements and management
- Technologies and management practices
- Economics of production

Generally research and demonstration projects fall into more than one of the key areas therefore are reported individually. It should also be noted that not all the research is done at the research farm; projects have been conducted in partnership with other farms and in supplementary areas of the Yukon. The partnerships take advantage of the on farm expertise, and site variation give insight into the diverse climates in the Yukon and the potential that may exist in other areas beyond the research farm. Climate data was collected in these supplementary areas to better understand the fluctuations in weather in agricultural areas. The multitude of information from research projects conducted lead to recommendations for Yukon agricultural.

Site Descriptions

HN Site (Heiko Nyland)

Research conducted: Oilseeds Research

The site is located in the central Yukon and therefore is influence by the warmer summer continental climate. It is located west of Pelly Crossing along the Pelly River near Crosby Creek. The site is on a north bench of the Pelly River, with good sun exposure.

Carmacks/LSCFN Site (LSCFN Community Garden)

Research conducted: Climate and Soil Temperature Monitoring

The site is located in the central Yukon and is also influenced by the continental climate resulting in warmer growing conditions. This location is home to the field garden for the Little Salmon Carmacks First Nation (LSCFN). The garden is located within a small 1.5 hectare cleared area, on a slight east facing aspect of the lower edge of the Yukon River.

TA Site (Tulio Albertini)

Research conducted: Climate and Soil Temperature Monitoring

The site is located in the Yukon River Valley, 20 km north of Whitehorse. The climate and soil monitoring was setup on a south-east facing slope on an upper terrace, on the edge of a dryland hay field.

TR Site (Tom and Simone Rudge)

Research conducted: Climate and Soil Moisture Monitoring

The site is positioned in the Takhini Valley, on the north side of the Takhini River and the east side of Flat Creek. The climate and soil sensors were set up on the edge of a 30 hectare flat forage field on upper terrace of the Takhini River.

BD Site (Bill and Barbara Drury)

Research conducted: Climate and Soil Temperature Monitoring

The site is located in the Takhini Valley on an alluvial terrace adjacent to the south side of the Takhini River, just east of the Takhini River Bridge along the Alaska Highway. The site has some low lying wetter areas with undulating terrain due to thawing of ice lenses (thermokarst) which spans over a large clearing of approximately 55 hectares.

GZ Site (Gary and Pamela Zgeb)

Research conducted: Climate Monitoring

This site is located on the north side of the Takhini Valley, on an alluvial terrace next to the Takhini River, close to a raspberry orchard, on a slightly sloping, south face. This is a small area with little air movement resulting in frequent frosts.

SM Site (Steve and Bonnie Mackenzie-Grieve)

Research conducted: Oilseeds and Potato Trials and Climate Monitoring

SM site is located in the Yukon River Valley, near the south tip of Lake Laberge. The weather station and field experiment were located on the northwest corner of a large 50 ha clearing. The site is on a slightly sloping east aspect on an alluvial terrace next to the Yukon River. This is an irrigated site with oats as the previous crop.

WG Site (Wayne and Allison Grove)

Research conducted: Climate and Soil Moisture Monitoring

This is an irrigated site, located on a lower bench in the Takhini Valley, to the east of the TR site. The climate and soil moisture monitoring was set up near a south facing slope on a 33 hectare hay field with a slight south aspect.

RF Site (Yukon Government Research Farm)

Research conducted: Oilseeds, Alfalfa, Forage and Raspberry Research and Climate Monitoring

This site is located in the Gunnar Nilsson and Mickey Lammers Research Forest located south of the Klondike Highway and Takhini Hot springs Rd. Junction. The research is conducted on 2 hectares in the northeast corner of the Research Forest on a level field surrounded by a dominantly Lodgepole Pine forest providing shelter from winds, consequently creating a frost pocket. The soil, landscape and climatic properties of the site are typical of those encountered at many farms in the southwest region of the Yukon. The area was cleared in 1987 of willow, aspen, spruce, lodgepole pine, sheperdia spp, and bearberry and has been worked intensively for a variety of research since.

Photo: Yukon Government Research Farm

1.0 YUKON CLIMATE MONITORING

Co-operators: Tulio Albertini, Little Salmon and Carmacks First Nation, Bill Drury, Wayne Grove, Gary Zgeb, Agriculture and Agri-Food Canada (PFRA)
Location: Various Agricultural Locations, YT
Funding: Yukon Government, APF Science and Innovation
Objective: To understand the variability in climate at various locations in the Yukon.

Introduction

Climate is the major limiting factor to agriculture in the Yukon due to a short frost free period and lack of heat units during the growing season.

The climate data from the past growing season is tabulated and used to measure agroclimatic capability. The agroclimatic capability is a measure of the degree of limitation imposed by climate on agricultural production and a measure of the amount of heat available to crops during the growing season. The agroclimatic capability is modified to account for local climate patterns, such as killing frost (-2.2°C), daily average temperature and day length. Table 1.1, outlines the agroclimatic classes, from Class 1 (no restrictions) to Class 7 (unable to be used for any agricultural purpose). The agroclimatic capability is based on Growing Degree Days (GDD), GDD are calculated beginning the fifth consecutive day of the year with daily mean temperatures above 5°C, and terminated the day of the first killing frost occurring after July 15. This killing frost temperature does not need to occur as a daily mean temperature, but rather at any moment of a day. Although the specific killing frost temperature differs between crops, for the purpose of determining the end of the growing season a temperature of -2.2°C is used as a standard for cool season crops. However crops such as potatoes have a killing frost closer to 0°C and this would result in a different end of season for this crop.

Table 1.1: Definitions and operational constraints of agroclimatic capability classes for cultivated agriculture in the Yukon Territory

Class 1	1400-1600 GDD	These lands have no significant limitations that restrict the production of the full range of common Canadian agricultural crops
Class 2	1200-1400 GDD	These lands have slight limitations that restrict the range of some crops but still allow the production of grain and warm season vegetables
Class 3	1050-1200 GDD	These lands have moderate limitations that restrict the range of crops to small grain cereals and vegetables
Class 4	900-1050 GDD	These lands have severe limitations that restrict the range of crops to forage production, marginal grain production and cold-hardy vegetables.
Class 5	700-900 GDD	These lands have very severe limitations that restrict the range of crops to forages, improved pastures and cold-hardy vegetables.
Class 6	<700 GDD	These lands have such severe limitations for cultivated agriculture that cropping is not feasible.

GDDs are calculated using the average daily temperature minus a basic mean temperature of 5°C required for cool season crops. For example, if the daily mean temperature is 10°C, the GDD total is 5. Similarly if the daily mean temperature is 16°C, GDD equals 11. However, in the instance that a mean temperature is 5°C or lower, GDD would equal 0.

The longer day length experienced in the Yukon has a positive effect on the crop growth which is not accounted for in a simple GDD calculation. To account for the boost plants receive from the long

hours of daylight north of 60° latitude the GDD is adjusted upward and reported as Effective Growing Degree Days (EGDD) as outlined in the calculation of the day length factor in the Land Suitability Rating System for Agriculture Crops (Technical Bulletin 1995-6E). For example, the 947 GDD recorded at Whitehorse Airport, is multiplied by a factor of 1.16 and becomes 1099 EGDD. The daylight factor changes with latitude, for example in Dawson a factor of 1.18 is used and for Watson a factor of 1.14 is used.

Over the years the comparisons of different locations in the Whitehorse area have shown interesting contrasts between growing degree day (GDD) values. These differences are mainly attributed to site profiles; namely elevation, slope, aspect, and wind (i.e. frost drainage or entrapment by geography or forests). In 2004, the Agriculture Branch set out to record temperatures at various farm sites in the Whitehorse area, particularly in the Takhini River Valley in order to assess their agroclimatic capability classification. This provides an opportunity to compare and contrast microclimates of these different agricultural settings. In 2007 data loggers were set up through the Yukon and Takhini River Valleys to continue this comparative analysis.

Although most agriculture exists in the Whitehorse area, other areas of the Yukon have a strong agricultural base. With the utilization of climate data from Environment Canada, Yukon Government weather stations and our own temperature data, agroclimatic capability was calculated for Haines Junction, Watson Lake, Dawson, Mayo, Pelly Farms and Carmacks. The central Yukon has been known to have a warmer summer resulting in a higher agroclimatic capability rating, 2007 was no different. This research was further extended to look at the agroclimatic capability of these areas over the past 10 years, to determine the most recent trends in agriculture capabilities in the Yukon.

Methodology

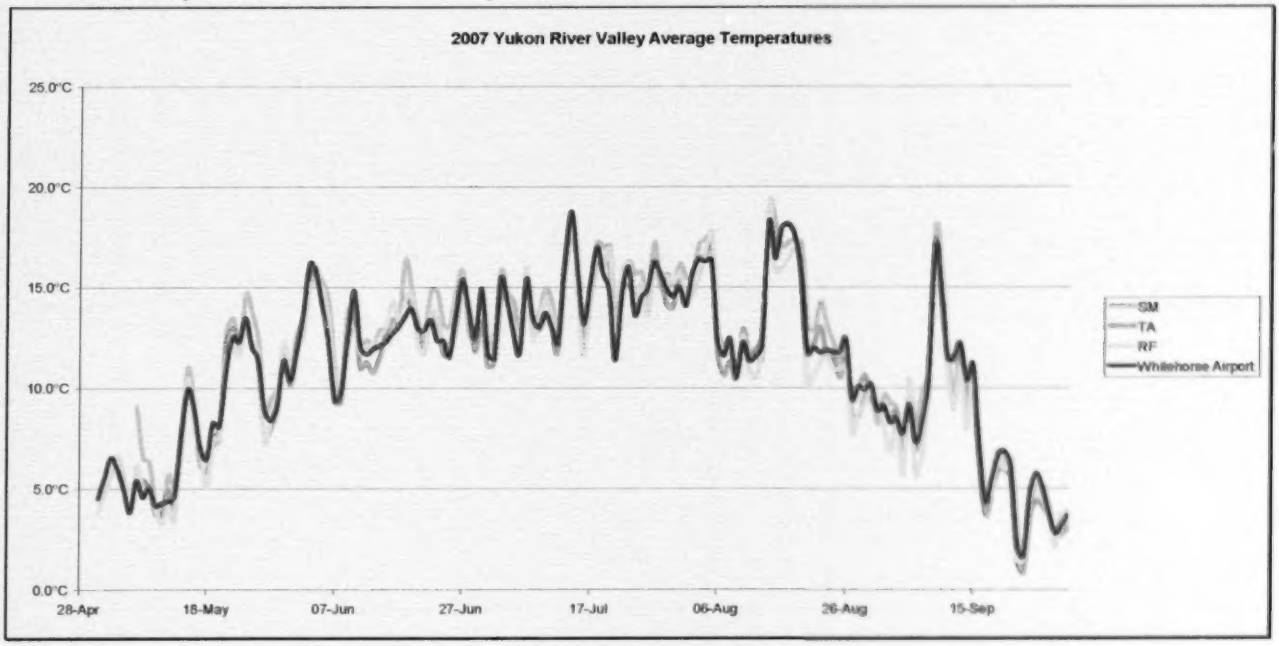
Data loggers were used to record ambient temperature throughout the growing season. These units were placed at four different locations in the Takhini River Valley, two locations between Whitehorse and Lake Laberge, one at the junction of the Takhini and Yukon River Valleys, and one location in the central Yukon located near Carmacks. Data was recorded using HOBO (Onset® Computer Corporation) air temperature monitors or WatchDog (Spectrum Technologies, Inc) weather stations. The HOBO is a small battery operated unit, these were fixed approximately two meters (six feet) above ground on a steel bar using Stevenson screens (plastic protective plates) for solar shielding. This height was used in order to avoid stagnant air movement at ground level, where boundary layers tend to occur. Furthermore, this height factor could adjust for non-uniform terrain common at some of the chosen sites, hence resulting in more representative air temperature samples. The WatchDogs are remote weather stations used to record real time weather information, including temperature, wind speed and direction, relative humidity, rainfall, and solar radiation. The units were set up at the WG, TR, SM, and RF sites. The WatchDog weather stations were set up in open areas away from irrigation at 2 meters above the ground. The recording period started in early May, depending on the site, and lasted until the end of September.

Data was also collect from the Environment Canada (EC) online climate data and Yukon Government (YG) weather stations for locations in other agriculture areas of the Yukon. These areas included Haines Junction (EC), Watson Lake Airport (EC), Dawson Airport (EC), Mayo Airport (EC), Pelly Farms (EC & YG), Carmacks (EC, YG, and Ag. Branch) and RF site (YG).

Results and Discussion

The Whitehorse area weather data from the 4 weather stations in the Takhini Valley along with data from the Yukon River Valley between Whitehorse and Lake Laberge, and data from the junction of Yukon and Takhini Rivers were tabulated and graphed using Microsoft excel. The graphs and tables were set up to look at micro climate variability in the Whitehorse area. Graph 1.1 looks at the temperatures in the Yukon River Valley between Whitehorse and Lake Laberge, including the RF site which falls in this area, but is also affected by the Takhini River Valley.

Graph 1.1: Temperature of the Yukon River Valley between Whitehorse and Lake Laberge, including Whitehorse Airport and the RF site at the junction of the Takhini and Yukon River Valleys



The temperatures in the Yukon River Valley are very similar with little difference visible in the Graph 1.1. Closer observations shows spikes of warmer weather observed at SM and the Whitehorse Airport and lower temperatures on average at the RF and TA. Further evaluation of the GDD/EGDD and growing season also found some more notable differences in growing season length and very little difference in the EGDD as observed in Table 1.2.

A weather station comparison was conducted at the RF site between the YG weather station and the Agriculture Branch WatchDog weather station. The two weather stations are located less than 1 km away from each other. The WatchDog weather station was set up in late June and collected climate data for the remainder of the growing season. This data was then compared to the climate data from the YG weather station and when graphed the images were very near identical with the exception of rainfall occurrences showing some variability which could be contributed to very isolated rain showers commonly seen traveling through the valley. This comparison added to the confidence in the data collected from the Watchdog weather stations.

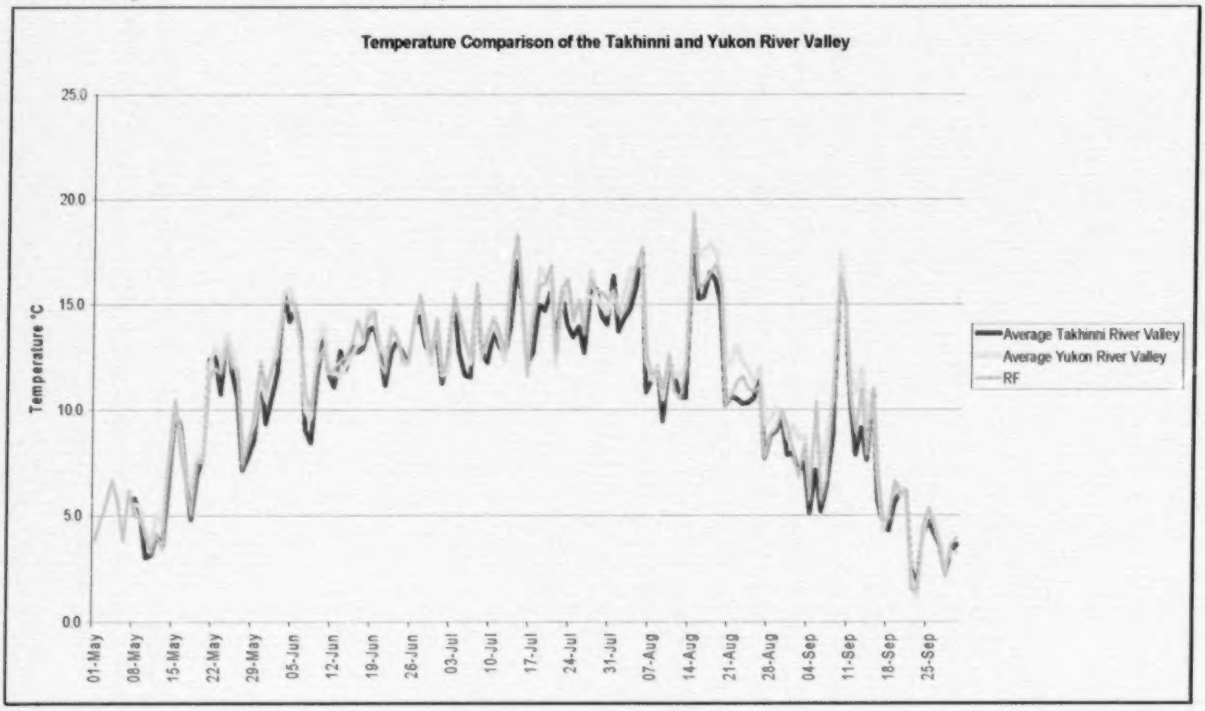
Table 1.2: Agroclimatic data for the Yukon River Valley including the RF site at the Junction of the Yukon and Takhini River Valley

	Jct. of Takhini & Yukon	Yukon River Valley		
	RF	TA	SM	Whitehorse Airport (EC)
Sum of GDD	831	927	900	947
Sum of EGDD	964	1076	1043	1099
Start of growing season	18-May	18-May	16-May	18-May
End of growing season (first killing frost -2.2°C)	27-Aug	22-Sep	27-Aug	22-Sep
Agroclimatic capability class	Class 4	Class 3	Class 4	Class 3
Number of frosts during growing season	20	5	9	6
Number of frosts experienced before July 15	16	3	7	4
Number of frosts experienced after July 15	4	2	2	2
Last spring frost	06-Jul	27-May	09-Jun	09-Jun
First fall frost	12-Aug	27-Aug	12-Aug	27-Aug

Site TA had a much longer growing season compared to site SM which resulted in a higher EGDD. Although the longer season is not a surprise because the TA site has very good frost drainage due to its sloping terrain, any gain in EGDD for the TA site is usually offset by the cooler temperature experienced at the higher elevation of this site. In 2007 there were no apparent differences between the TA site and Whitehorse Airport. The Whitehorse Airport also experienced a longer season due to good frost drainage. When compared to the TA site with the same start and end of growing season, the calculated EGDD is only slightly higher. Again the higher elevation of the TA site should show noticeably cooler temperature, but this is not observed as there is only a 23 EGDD difference between the sites. In general the three sites in the Yukon River Valley were very similar as observed in the narrow range of 1043 to 1099 EGDD.

The RF site which falls at the junction of the Yukon and Takhini River Valley system was compared with both Valleys climate data. The RF site appears to fall somewhere between the two as indicated by Graph 1.2. The lack of frost drainage as shown by the highest number of frost occurrences during the growing season (seen in Table 1.2 & 1.3) has resulted in cooler temperatures for this site reducing the total EGDD. The RF site and weather station is surrounded by lodge pole pines that tend to trap cooler air not allowing it to flow out. Better frost drainage at this site, would increase the seasonal temperature making it more like the Yukon River Valley, but for this site frost drainage is the limiting factor.

Graph 1.2: Temperature of the Takhini River Valley compared to the Yukon River Valley, including the RF site at the junction of both river valleys



The Takhini River Valley is cooler compared to the Yukon River Valley as observed in graph 1.2. This is also noted in the lower EGDD tabulated for 2007. The Yukon River Valley ranged between 1043-1099 compared to the lower 741-937 EGDD experienced in the Takhini River Valley as outlined in Table 1.2 and 1.3. This is a difference of over 100 EGDD between the highest in the Takhini Valley and the lowest in the Yukon Valley, identifying that the two valley systems are different and the Takhini Valley has more agroclimatic limitations.

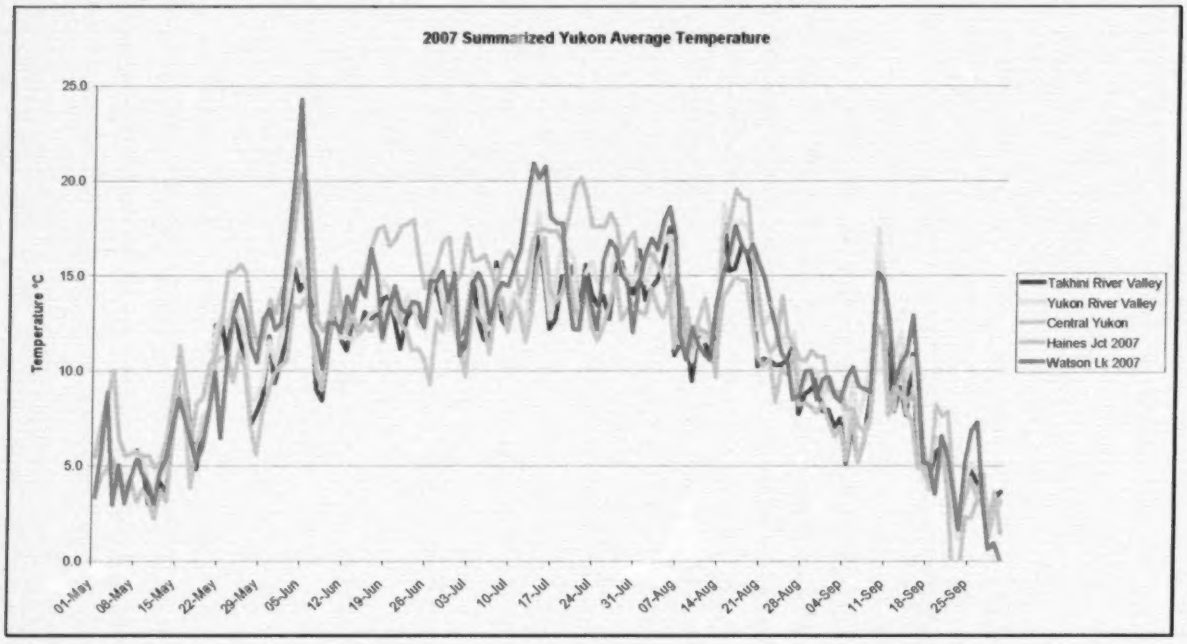
Table 1.3: Agroclimatic data for the Takhini River Valley including the RF site at the junction of the Yukon and Takhini River Valley

	Takhini Valley				Jct. of Takhini & Yukon
	BD	TR	GZ	WG	RF
Sum of GDD	767	639	714	808	831
Sum of EGDD	890	741	829	937	964
Start of growing season	23-May	23-May	23-May	18-May	18-May
End of growing season (first killing frost -2.2°C)	27-Aug	12-Aug	27-Aug	27-Aug	27-Aug
Agroclimatic capability class	Class 5	Class 5	Class 5	Class 4	Class 4
Number of frosts during growing season	9	8	16	12	20
Number of frosts experienced before July 15	6	8	12	12	16
Number of frosts experienced after July 15	3	0	4	0	4
Last spring frost	09-Jun	09-Jun	06-Jul	09-Jun	06-Jul
First fall frost	12-Aug	12-Aug	12-Aug	27-Aug	12-Aug

The wider EGDD range experienced in the Takhini Valley system indicates that there is more microclimate variability through this valley system. This area has an EGDD variability of 196 EGDD between site WG and TR. This large difference is mostly due to the early killing frost of August 12th experience at the TR site, but even without the TR site data there is still variability of over 100 EGDD as observed between the GZ and WG sites.

The climate data for locations outside of the Whitehorse area was collected from online data available from Environment Canada (EC) and the Yukon Government (YTG) weather stations. This data included locations such as Haines Junction, Watson Lake, Mayo, Pelly Farms and Dawson. The data for Carmacks was not collected as the Ag. Branch HOBO datalogger did not operate properly over the 2007 growing season and the locations of the EC weather station was not representative of the Carmacks agricultural lands due to its higher elevation. The data for Dawson, Mayo and Pelly (and Carmacks when the data is available) is tabulated and average to represent the central Yukon. An overview of the 2007 Yukon climate data can be observed in Graph 1.3.

Graph 1.3: 2007 Average Yukon Temperatures for the Central Yukon (Dawson, Mayo, and Pelly Farms), Haines Junction, Watson Lake, Yukon River Valley (between Whitehorse and Lake Laberge) and Takhini River Valley



In Graph 1.3 there are some noticeable trends that can be observed, for example the central Yukon and Watson Lake area are seen to have a warmer climate as indicated by the noticeable separation of the graph lines above the other locations. Haines Junction is on the cooler side as indicated by its prominence towards the lower temperatures. Table 1.4 summarizes this better through the calculation of EGDD and land capabilities.

Table 1.4: Agroclimatic data for the Takhini River Valley, Yukon River Valley, Central Yukon locations, Haines Junction and Watson Lake

	Takhini Valley	Yukon River Valley	Central Yukon Climate			Haines Jct. (EC)	Watson Lake Airport (EC)
	Range	Range	Pelly Farms (YT)	Mayo Airport (EC)	Dawson Airport (EC)		
Sum of GDD	639 - 808	831 - 947	1296	1200	1142	704	1027
Sum of EGDD	741 - 937	964 - 1099	1529	1417	1348	816	1171
Start of growing season	May 18 - May 23	May 16 - May 18	Apr 26	May 5	May 5	May 22	May 17
End of growing season (first killing frost - 2.2°C)	Aug 12 - Aug 27	Aug 27 - Sep 22	Sep 22	Sep 22	Sep 21	Aug 28	Sep 30
Agroclimatic capability class	Class 5 - Class 4	Class 4 - Class 3	Class 1	Class 1	Class 2	Class 5	Class 2
Number of frosts during growing season	8 - 16	5 - 20	23	11	17	12	9
Number of frosts experienced before July 15	6 - 12	3 - 16	19	9	8	9	4
Number of frosts experienced after July 15	0 - 4	2 - 4	4	2	9	3	5
Last spring frost	Jun 9 - Jul 6	May 27 - Jun 9	May 21	May 21	May 21	Jun 9	May 23
First fall frost	Aug 12 - Aug 12	Aug 12 - Aug 27	Aug 28	Sep 7	Aug 9	Aug 12	Sep 17

Table 1.4, as indicated by the EGDD and agroclimatic capability, shows that the central Yukon is much warmer, resulting in better range of cropping options as indicated by the improved agroclimatic capability of Class 1 & 2. Although there are warmer temperatures in the Central Yukon the area is as prone, if not more prone to season frost occurrences as indicated by the 11 to 23 frost occurrences during their growing season.

Watson Lake has a marked increase in EGDD compared to the Whitehorse area, but agroclimatic capability was rated similarly to Whitehorse as Class 3 agroclimatic capability, which is same as the higher end of the range for the Yukon River Valley around Whitehorse. Haines Junction growing conditions were similar to the Takhini River Valley values, having an agroclimatic capability of Class 5 and an EGDD of 816.

1.1 Ten year comparison between Yukon agricultural areas

Results and Discussion:

As a result of the exceptional agroclimatic capabilities experience in the central Yukon in 2007 and the general knowledge that the central Yukon is warmer, an evaluation of the agroclimatic capabilities experienced in different Yukon agricultural zones over the last 10 years was conducted The zones were split up similar to the 2007 yearly climate evaluation with the exception of the Takhini River Valley not being included in the evaluation. The agricultural zones included the central Yukon, southern Yukon, Whitehorse area, and Haines Junction.

This data was collect from Environment Canada online data, or from historical data from the Yukon government weather stations. Sites included:

- Southwest Yukon:
  - Haines Junction (EC)
- Southern Yukon:
  - Watson Lake Airport (EC)
- Whitehorse area:
  - Whitehorse Airport (EC)
  - Site RF (YG)
- Central Yukon:
  - Pelly Farms (EC & YG)
  - Mayo Airport (EC)
  - Dawson Airport (EC)

Carmacks was omitted from this evaluation due to incomplete data and the EC weather station is not representative of the areas agricultural lands.

Table 1.5 highlights the average and range of the last 10 years EGDD, start and end of growing seasons, agroclimatic capability class and number of frosts during the growing season. For more detailed information on yearly bases for 1998 to 2007 refer to appendix table 1.

The central Yukon had the highest agroclimatic rating, with an average rating of Class 2 which is defined as having limitations that restrict the range of some crops but still allow the production of grain and warm seasonal vegetables. Pelly Farms, Mayo and Dawson were the sites evaluated in the central Yukon. The Pelly and Mayo sites were observed to be slightly warmer and have longer season compared to Dawson.

The Whitehorse area is represented by data from Whitehorse Airport and the RF site. These two sites are vastly different as one site has exceptional frost drainage and the other site does not. These two sites averaged Class 3 to 5, which would be a significant reduction in agroclimatic capability compared to the central Yukon. The Whitehorse area would have some level of heat limitations which restricts the range of crops.

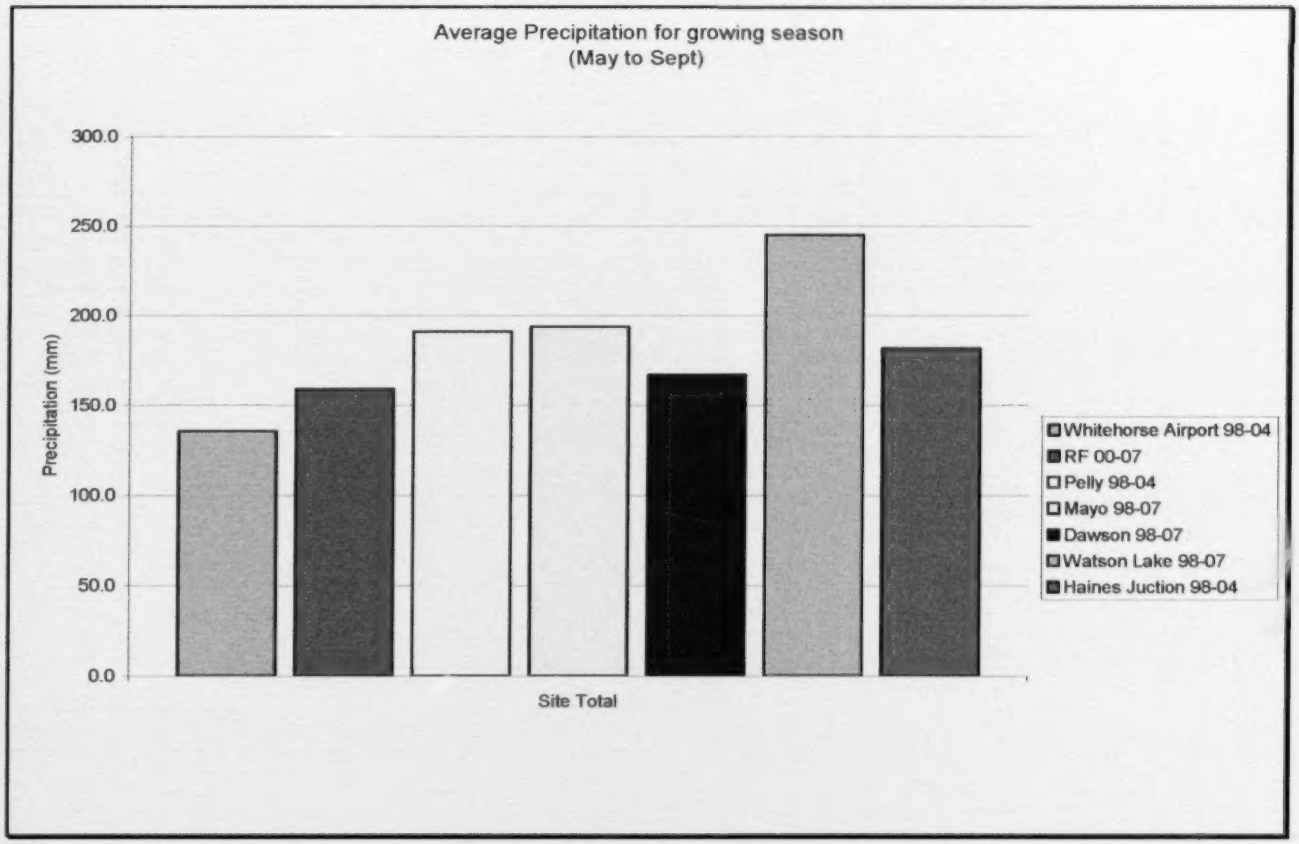
Haines Junction has an average of Class 4 agroclimatic capability. Even with the high incidence of frost experienced in this area, the area does have growing conditions suitable for forage production and cold hardy vegetables, and marginally for grain production.

Table 1.5: 10 year agroclimatic data for agricultural zones in the Yukon

		Year	Range			Average
Whitehorse Area	Whitehorse Airport (EC)	EGDD	815	-	1350	1072
		Start of growing season	24-Apr	-	19-May	07-May
		End of growing season (first killing frost -2.2°C)	30-Aug	-	30-Sep	15-Sep
		Agroclimatic capability class	Class 5	-	Class 2	Class 3
		Number of frosts during growing season	4	-	22	11
	RF (YT)	EGDD (98-00 from research report)	693	-	1263	886
		Start of growing season	27-Apr	-	22-May	10-May
		End of growing season (first killing frost -2.2°C)	01-Aug	-	02-Sep	19-Aug
		Agroclimatic capability class	Class 5	-	Class 2	Class 5
		Number of frosts during growing season	5	-	38	22
Central Yukon	Pelly Farms (YTG & EC data)	Sum EGDD:	991	-	1529	1224
		Start of growing season:	26-Apr	-	17-May	05-May
		End of growing season (first killing frost -2.2°C)	19-Aug	-	22-Sep	06-Sep
		Agroclimatic capability class	Class 4	-	Class 1	Class 2
		Number of frosts during growing season	6	-	29	14
	Mayo Airport (EC)	EGDD	1042	-	1470	1283
		Start of growing season	21-Apr	-	17-May	03-May
		End of growing season (first killing frost -2.2°C)	19-Aug	-	27-Sep	14-Sep
		Agroclimatic capability class	Class 4	-	Class 1	Class 2
		Number of frosts during growing season	2	-	21	11
	Dawson Airport (EC)	EGDD	833	-	1348	1086
		Start of growing season	26-Apr	-	17-May	08-May
		End of growing season (first killing frost -2.2°C)	21-Jul	-	24-Sep	30-Aug
		Agroclimatic capability class	Class 5	-	Class 2	Class 3
		Number of frosts during growing season	1	-	24	13
Southwest Yukon	Haines Junction (EC)	EGDD	773	-	1159	947
		Start of growing season	27-Apr	-	22-May	09-May
		End of growing season (first killing frost -2.2°C)	21-Aug	-	25-Sep	06-Sep
		Agroclimatic capability class	Class 5	-	Class 3	Class 4
		Number of frosts during growing season	12	-	38	18
Southern Yukon	Watson Lake Airport (EC)	EGDD	993	-	1332	1153
		Start of growing season	23-Apr	-	22-May	10-May
		End of growing season (first killing frost -2.2°C)	08-Sep	-	30-Sep	21-Sep
		Agroclimatic capability class	Class 4	-	Class 2	Class 3
		Number of frosts during growing season	1	-	15	8

The southern Yukon or Watson Lake averaged an agroclimatic capability of Class 3, defined as lands with moderate limitations that restrict the range of crops to small grain cereals and vegetables. The agroclimatic rating of Class 2 to 4 for Watson shows improved agroclimatic capabilities compared to Whitehorse. Watson Lake also benefits from traditionally more precipitation through the growing season. The evaluation of the 10 year precipitation trends from May to September has been outlined in Graph 1.4.

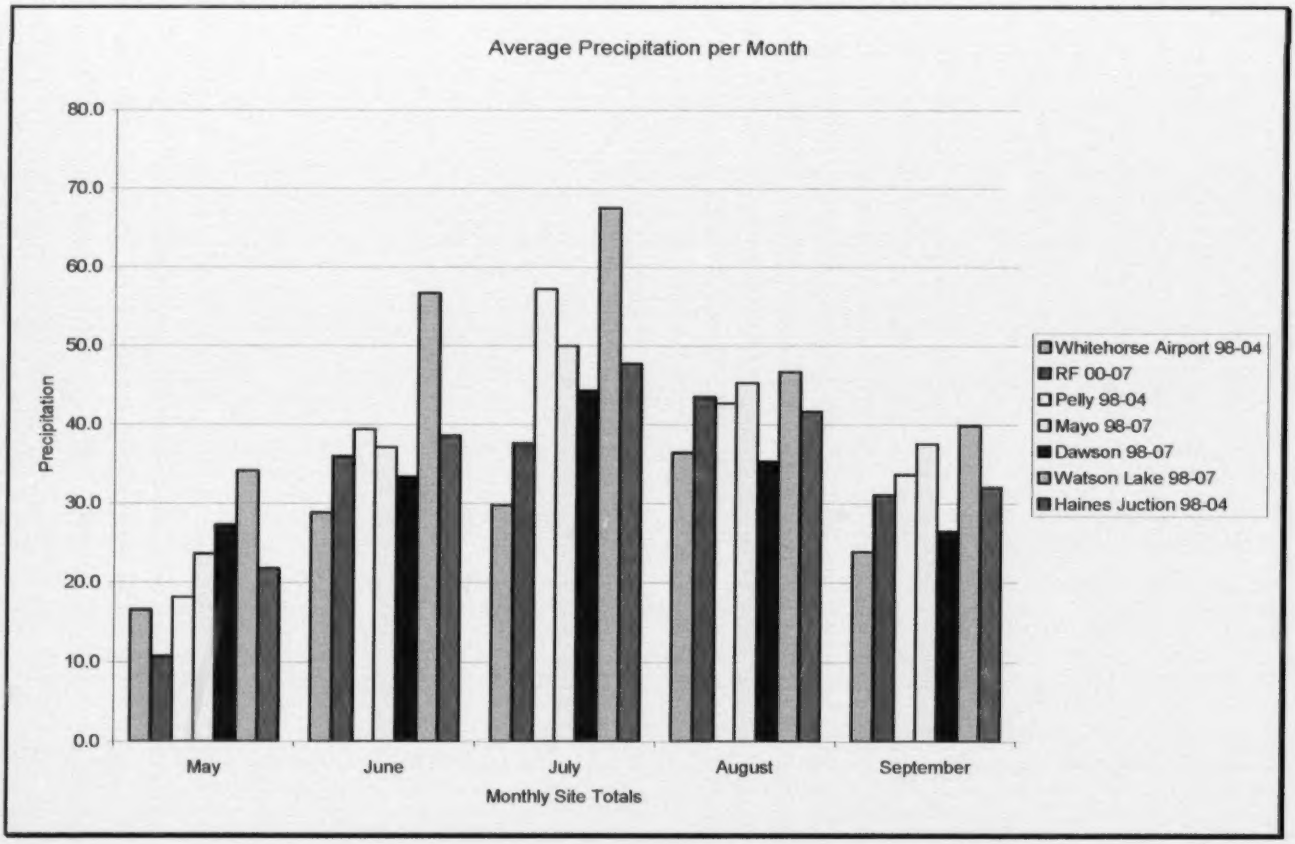
Graph 1.4: Yukon average precipitation for May to September based on available 10 year data



Watson Lake receives approximately 245 mm of precipitation from May to September based on this 10 year evaluation; all other agricultural sites in the Yukon receive less than 200 mm of rain during this period. It is known that there is limitation to agriculture in the Yukon due to the lack of rainfall. Irrigated hay production in the Whitehorse area produces 3 times the yield compared to none irrigated production. Locations, such as Watson Lake would require less irrigation and dryland sites should see slightly better yields due to this increase in precipitation.

The profile for the rainfall during the season is very similar across the Yukon as seen in Graph 1.5, with very little rain at the beginning of the season and peak rainfalls in July.

Graph 1.5: Yukon average precipitation data per month based on available 10 year data



2.0 UNDERSTANDING SOIL TEMPERATURE IN THE PLOUGH LAYER

Co-operators: *Tulio Albertini, Bill Drury*
Location: Whitehorse Area, YT
Funding: YG, APF Science and Innovation
Objective: To understand the variability in soil temperature in the plough layer over the growing season.

Introduction

Soil temperature measurements within the plough layer are important in order to understand the influence soil temperatures have plant and microbial activity. The Soil temperature has a direct effect on microbial growth and development, organic matter decay, seed germination, root development, and water and nutrient absorption by roots. In general, the higher the temperature the faster these processes occur. General soil microbial activity and organic matter decomposition virtually cease below about 5°C (The natures and properties of soils, Brady & Weil, 2002). In cold soils microbial activity is reduced, minimizing the cycling of bio-available nutrients, for example: minimum soil temperature critical for bacterial nitrogen fixation is 10°C (Rice *et al*, 1995). Soil temperatures also greatly influence growth and yields of plants. Soil cover, slope aspect, soil moisture, texture and level of organic matter all affect the rate and retention of heat absorption and loss.

Prior to this experiment, soil temperature data for the Yukon had been collected in lower depths in context to permafrost. For this experiment 3 sites recorded soil temperature values in the plough layer. In contrast to the permafrost data, these sensors were deployed at root zone depths, 0-20 cm deep.

Materials and Methods

HOBO dataloggers manufactured by Onset® Computer Corporation were used for data capture. The units were installed in the soil of 3 different hayfields in the Whitehorse area. The sites of these hayfields included the RF, TA and BD sites. The RF site is located in a small clear area of a spruce forest near the junction of the Takhini and Yukon Rivers. The TA hayfield is located on an upper terrace of the Yukon River Valley between Whitehorse and Lake Laberge on a south east facing slope. The BD hayfield is located along the Takhini River; this is a large cleared area, on a flat lower terrace adjacent to the river.

A hole was made in the in the soil and two smaller pilot holes for the sensor were made horizontally in the soil for the sensors. The soil sensors were installed in the face of the hole horizontally at 10cm and 20 cm. The soil was then backfilled and packed around the sensors and plugged into the HOBO data recorder.

The datalogger and probes were picked up in October and the data was downloaded to a computer.

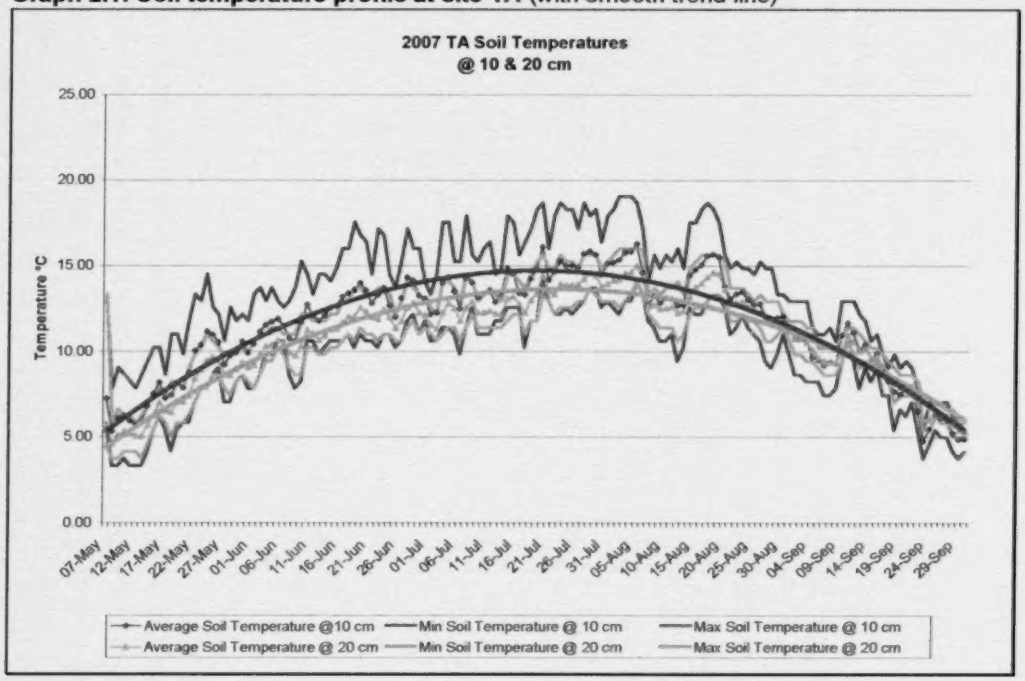
Results

The data from the HOBOs was converted to Microsoft Excel where the daily average soil temperature was calculated and plotted along with daily minimum and maximum soil temperatures as seen in Graph 2.1, 2.2 & 2.3. A trend line was added to each of the graphs showing a gradual increase in temperature over the season eventually peaking in mid July, followed by a gradual decrease in temperature. The 20 cm soil temperature from the beginning to the middle of the season on average is lower by 1 to 2°C, but as the season progresses and the average soil temperatures start to decrease the 20 cm soil depth retained heat longer. There was more variability in temperature observed at the 10 cm as seen by increased gap between min and max temperatures throughout the season.

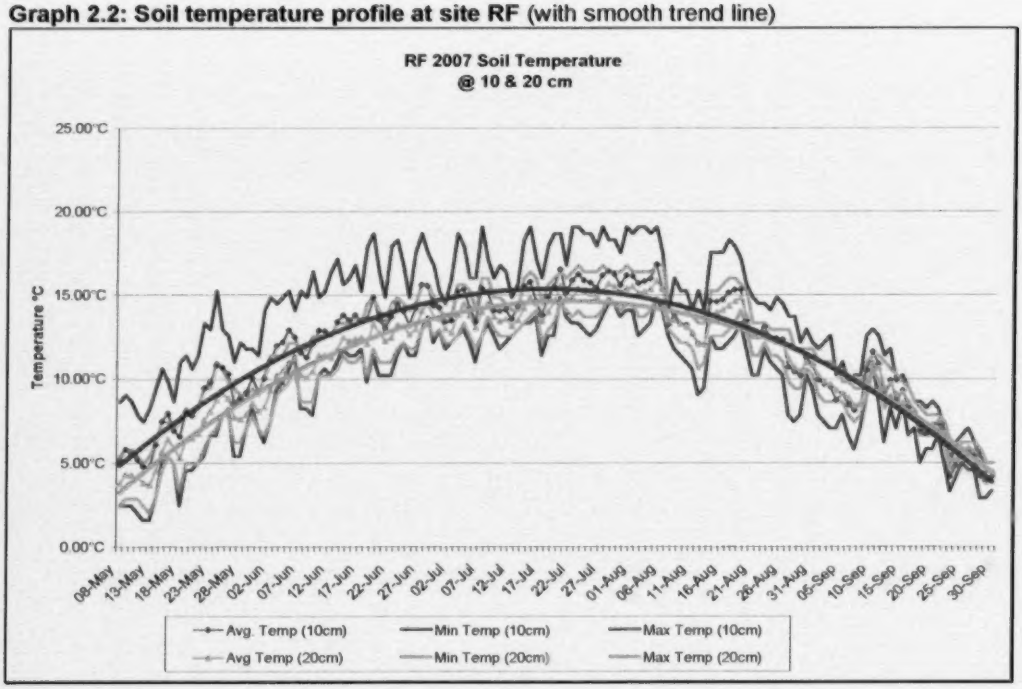
The sites were all located in the Whitehorse area, and the temperature profiles were very similar as seen in the trend line peaking between 14°C to 18°C depending on soil depths and site. The RF and TA sites were most similar as seen by the trend line peak at around 15°C at 10 cm and 14°C at 20 cm, with the RF being slightly warmer at both soil depths. The soil temperature at the BD site was warmer and was the only site to have temperatures spike above 20°C at 10 cm. The BD site on average reached a warmer peak temperature of 18°C at 10 cm and 17°C at 20 cm. This could be attributed to the larger cleared area absorbing more direct sunlight.

The critical temperature of 5°C where soil microorganism activity starts was already achieved at the BD site when soil probe was installed in early May, whereas the TA and RF sites were just starting to reach this critical temperature. Soil temperatures below 5°C; mark the end of any microbial activity, this event occurred in late September for 2 of the sites and site TA did not reach the 5°C temperature until October.

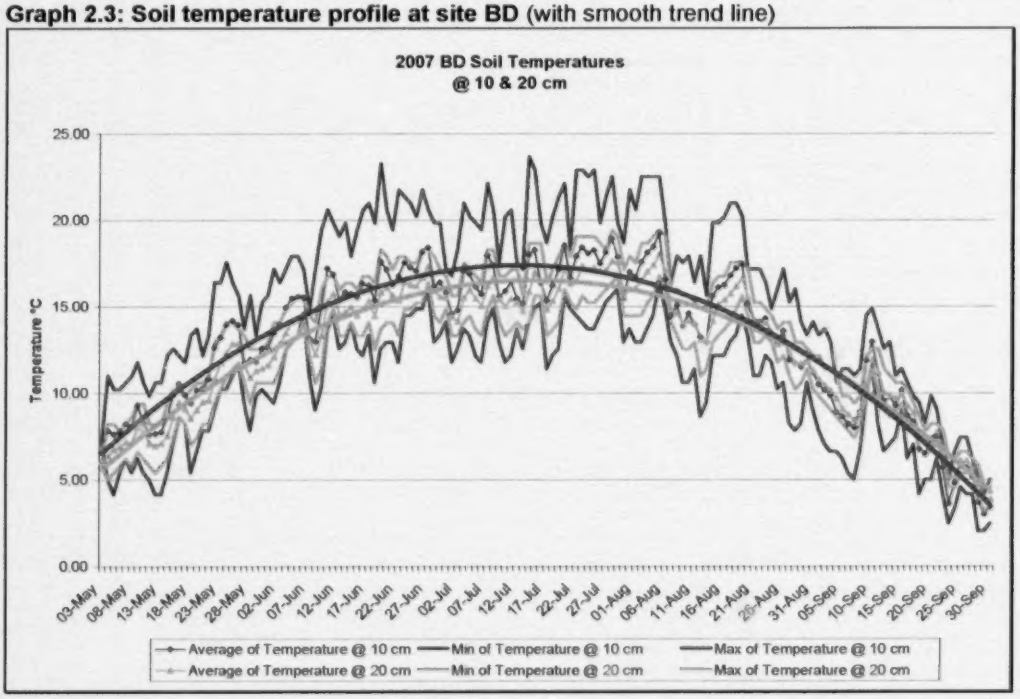
Graph 2.1: Soil temperature profile at site TA (with smooth trend line)



Graph 2.2: Soil temperature profile at site RF (with smooth trend line)



Graph 2.3: Soil temperature profile at site BD (with smooth trend line)



Discussion

Soil temperatures have an effect on plant growth and soil micro-organism activity. Minimum germination temperatures vary between crops and range from 1 to 16°C, with most crops preferring germination temperatures above 10°C (outlined in Table 2.1 and 2.2). Ten degrees Celsius was achieved between mid May and the beginning of June for these sites. The temperatures at the sites in this evaluation would limit seed germination for most crops, with the exception of cold hardy vegetables such as carrots, cabbage, cauliflower and lettuce. Most cereals and forage crops can germinate in these cooler soil temperatures although they prefer much warmer temperatures for germination as seen in Table 2.1, therefore the cooler soils delay germination and reduce seed emergence. Roots also function more effectively in warmer soils. In cool soils water and nutrient uptake tends to be slow. Optimum growth at these sites is going to occur when the soil temperatures peak, from mid June to mid August. Most crops prefer temperatures above 15°C for optimum growth which only occurred on average at the BD site and for a short period of time at the RF site. (Reference soil temperature ranges, The Nature and Properties of Soils, N.Brady & R.Weil).

Five degrees Celsius is the minimum temperature for microbial activity in soils. Activity doubles for every 10°C above this temperature until a maximum of 35-40°C. In the range of 5 to 18°C, in which these sites lie, the microorganism activity is limited. This reduces the amount of decomposition, nutrient cycling and nitrogen fixation (The Nature and Properties of Soils, N.Brady & R.Weil). The soils reach the minimum temperature for biological activity in early May and ends in late September to early October. Although the soil temperatures do not reach the optimum range for activity there is some level of decomposition and nutrient cycling from May to September in Yukon soils.

Cooler soils also limit the micro organism's ability to destroy toxic organic pesticides and pollutants in soils. Temperature control is critical for some new technologies that take advantage of the ability of certain microorganism to degrade petroleum products, pesticides and other compounds (The Nature and Properties of Soils, N.Brady & R.Weil).

Table 2.1: Germination Temperatures for Field Crops (Alberta Government)

	Minimum (°C)	Preferred (°C)
Cereals and Oilseeds		
wheat	4	20
barley	3-5	20
oats	5	20-24
canola/rapeseed	5 (Argentine)	15-20
	7-10 (Polish)	15-20
Forage Crops		
alfalfa	1	25
red clover	3	25
sweet clover	1	18-25
fescues	3	13-18
orchardgrass	4	18-20
timothy	4	18-22

Table 2.2: Germination Temperatures for Vegetables and Special Crops (Alberta Government)

	Minimum (°C)	Preferred (°C)
bean	8-10	16-30
beet	4	10-30
cabbage	4	7-35
carrot	4	7-30
cauliflower	4	7-30
celery	4	15-21
corn	10	16-32
cucumber	16	16-35
lettuce	2	4-27
onion	2	10-35
parsley	4	10-30
parsnip	2	10-21
pea	4	4-24
pepper	16	18-35
pumpkin	16	21-32
radish	4	7-32
rutabaga	4	16-30
spinach	2	7-24
squash	16	21-35
tomato	10	16-30

Conclusion

Soil temperatures at these sites in the Whitehorse area remain relatively cool during the growing season only reaching temperatures that support biological soil activity from beginning of May to the end of September. Cool soil temperatures slow down the process of pesticide breakdown, decomposition, nutrient cycling and nutrient uptake and reduce germination. Farm practices in the Yukon should take into consideration the cool soils in crop and farm management. Reduced pesticide use to minimize the residual effects of pesticides or use of row covers to warm the soil would be good strategies for Yukon farms. Slow decomposition and nutrient cycling under cool soils needs to be considered in seeding and fertilizing schedules. Lower germination of seeds in cooler soil can be adjusted by increasing seeding rates. Being aware of the soil temperature can help with the decision of what to plant, how to fertilize and spray and general soil management choices.

3.0 PRODUCTIVITY OF ALFALFA IN SUBARCTIC ENVIRONMENTS

Location: Yukon Government Research Farm

Funding: Yukon Government

Objective: To assess the productivity and longevity of Peace alfalfa (*Medicago sativa* cv Peace) in monoculture with late season harvests. To determine dry matter (DM) weight achievable under optimum conditions without Nitrogen fertilizer.

Introduction:

This experiment was initiated in 2005 and continued in 2007 to assess the change in dry matter production over subsequent harvests in south central Yukon conditions. The concern with alfalfa production in Yukon is the longevity of the alfalfa over time with cutting/grazing in August leading to overwinter death of plants resulting in reduced plant populations and yields. This experiment was carried out to see the effects of late season harvest on the stand over time (which emulates late season grazing).

Materials and Methods:

Plants were seeded by hand in a completely randomized design with eight 2x2 meter plots and one meter spacing in a slightly shaded area of the Yukon Government Research Farm. The design was initially setup for two treatments, a control and a peat based inoculation with TagTeam® (from Philom Bios). In the fall of the first year a split plot treatment was added to determine the effect of late season harvesting. Seed was hand sown in rows with 20 cm spacing. The plots were seeded May 30, 2005 at 15 kg/ha.

Results and Discussion:

For 2007 samples were not submitted for protein analysis, from the previous 2 years of study the protein levels were consistently around 20%. In the absence of protein analysis only dry matter yields were reviewed this year. Graph 3.1 shows the disconcerting trend that subsequent late season harvests result in reduced yields. The grouped bars on the graph are for one plot, and each bar represents the first year of harvest. In all cases except for plot 3 the trend is consistent with the lowest yields in those samples first harvested in 2005 and the highest yields from the samples first harvested in 2007. As shown on Table 3.1, samples that were first harvested in 2005, and again in 2006 show mean yields for 2007 of 3380 kg/ha whereas samples harvested in 2006 and again in 2007 yielded 5932 kg/ha and the samples that were only harvested in 2007 yielded 8711 kg/ha. From the very beginning we have reduced yields as compared to a stand that remains unharvested.

Graph 3.1: Summary of alfalfa yields

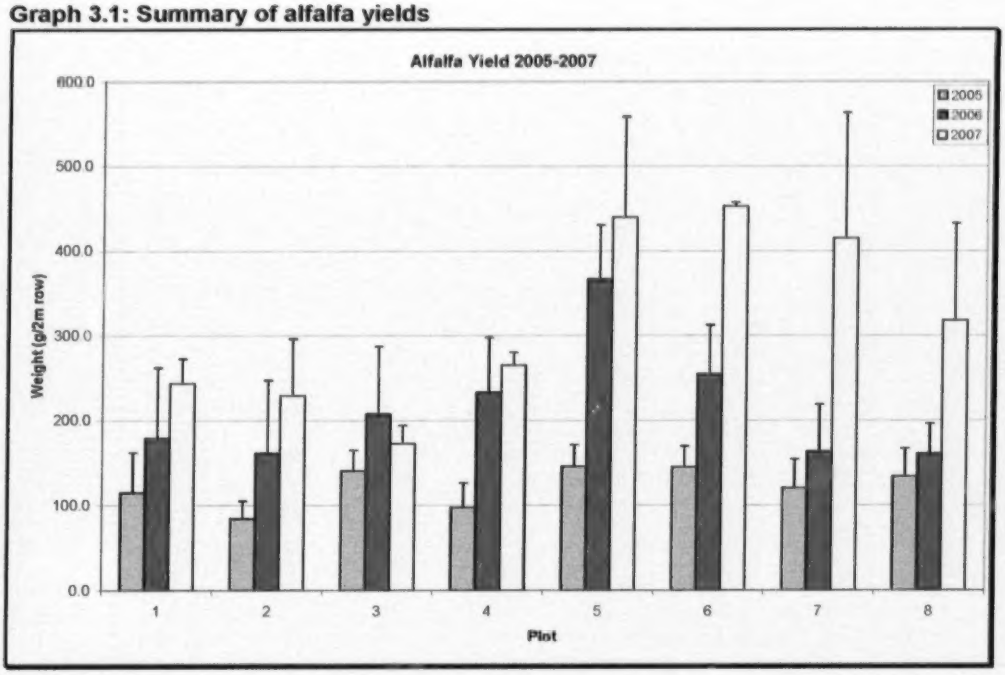


Table 3.1: Alfalfa yields by year (kg/ha)

	Minimum	Maximum	Mean
2005	2321	4014	3380
2006	4428	10067	5932
2007	4742	12443	8711

This trend outlines the importance of avoiding late season harvests or grazing of legume crops. Animals should only be let onto legume pastures after freeze up to minimize the impact on the forage stand.

We are seeing maximum yields of upwards of 12,000 kg/ha for Peace alfalfa, these yields are comparable to a one cut brome grass hay, we must be wary of directly comparing these crops as the brome hay is usually cut at least a month earlier than this experimental crop was harvested, this means that the alfalfa crop had a longer growing season.

4.0 CARROT VARIETY EVALUATION AND ECONOMICS OF PRODUCTION TRIAL

Location: Research Farm (Site RF), YT
Funding: Yukon Government, APF Science and Innovation
Objective: To determine which carrot varieties have the highest yields and determine the economics of a carrot operation in the south central Yukon

Introduction

This trial was conducted to determine if a carrot operation is possible in the south central Yukon and which varieties would provide an economically profitable yield.

Materials and Methods

The carrot varieties evaluated were purchased from a local Whitehorse garden store. All possible varieties were evaluated from the selection available at this garden centre. The carrots were planted at the RF site in 5x6 m rows split in half with 0.5 m between each row to allow for ease of cultivating and weeding. Varieties, suppliers and days to maturity are listed in Table 4.1.

Table 4.1: Carrot varieties planted, supplier and days to maturity

Carrot Variety	Supplier	Days to Maturity
Sweetness III	OSC	60 days
Little Finger	McKenzie	55-60 days
Tenderlong Imperator	McKenzie	65-80 days
Scarlett Nantes	McKenzie	68 days
Mezza Lunga Nantese	Gusto Italia	55-72 days
Nantes Touchon	McKenzie	60-70 days
Tendersweet Long Hybrid	McKenzie	75 days
Red Cored Chantenay	McKenzie	60-70 days
Red Cored Danvers	McKenzie	65-80 days
Nantes Coreless	Pike	-

The carrots were fertilized to soil test recommendations, and irrigated and weeded regularly. The carrots were seeded by hand, trying to seed at a rate of every 5 cm. The seeding rate was exceeded and the carrots were thinned to reduce crowding during the season as the carrots matured.
The carrots were seeded May 18th and harvested Aug 29th for a total of 103 days.

The carrots were cleaned, sorted and weighed. The carrots were sorted into Grade-A, deformed and small. Grade A carrots have no deformities (i.e.: multiple roots, or irregular shapes) and are larger than 2 cm in diameter.

Results

The 2007 growing season was normal for the Whitehorse area, with an agroclimatic capability of class 4. The carrots required little weeding as the site had been managed intensively in the past. Most of the time was spent on seeding, thinning and washing of the carrots. The thinning of the carrots was done on a subjective visual evaluation in order to reduce crowding of the carrots. Based on recommended seeding rates the carrots should have been thinned to a spacing of 5 cm between carrots. The visual thinning of the carrots was inadequate as the carrot density was too high, as observed in the table 4.2. The total number of carrots harvested from a 1 m row ranged from 28 to 54 and based on seeding recommendation the total number harvested should have been 20 carrots per meter. The two varieties with the highest density of carrots also had the most number of deformed and/or small carrots and either a lower average size or weight, which indicates that the higher density had a negative effect on the carrots average weight.

The Tendersweet Long Hybrid & Tender Long Imperator has a long slender appearance typical of store bought carrots. The Tendersweet had the highest number of Grade-A carrots harvested although these carrots lacked weight. The Imperator had a lot of lateral roots creating a poorer appearance.

The highest average weight carrots were the Red Cored Chantenay & Danvers and the Nantes Coreless & Touchone. The two red cored varieties had the highest average weight with the lowest total carrots harvested. These carrots with the lower densities had more room to grow and more access to moisture and nutrients resulting in larger carrots.

Although the larger carrots were thinned to the lower densities, the thinning was done based on perceived crowding in the rows therefore the larger carrots with the wider width required more thinning resulting in lower densities.

Table 4.2: Results of harvested carrots from a 1m section of the row

	Total Weight of 20 grade A carrots only	Average Weight of grade A carrots	Total # of Carrots harvested from 1 meter	# deformed carrots harvested:	# of small carrots harvested:	# of Grade A carrots harvested:	Average Carrot Length:	Average Carrot Width:
Red Cored Chantenay	2108	105.4	28	4	3	21	13.0	4.4
Red Cored Danvers	1966	98.3	28	5	2	21	15.3	4.1
Nantes Coreless	1522	76.1	33	2	3	28	16.3	3.4
Nantese Touchone	1499	74.95	38	12	1	25	16.0	3.1
Scarlett Nantes	1425	71.25	32	9	3	20	15.4	3.3
Little Fingers	1335	66.75	48	18	9	21	15.6	3.1
Tender Long Imperta	1314	65.7	40	11	3	26	17.0	3.1
Mezza Lunga Nantes	1287	64.35	36	4	3	29	16.7	3.1
Tendersweet Long Hybrid	1256	62.8	38	4	0	34	17.4	2.9
Sweetness III	1227	61.35	54	9	15	30	14.5	3.0

Table 4.3: Observations

	Observations
Red Cored Chantenay	Largest, highest foliage, one plant going to seed, red and green tops, uniform width.
Red Cored Denver	Tall leafy foliage, wide girth, triangular shape, moderate hairiness.
Nantes Coreless	Long, slim, few root hairs, uniform size
Nantese Touchone	Long wider girth, than Nantes Coreless, some green on tops, medium hairiness.
Scarlett Nantes	Consistent lengths and foliage growth
Little Fingers	Knarly, many small twisted carrots.
Tenderlong Imperator	Not uniform in length and width, reddish tinge on tops, not hairy, lots of lateral roots off main root.
Mezza Lunga Nantes	Not as uniform as Nantes Coreless, tops slightly green
Tendersweet Long Hybrid	Not very uniform in length & width, typically long & slender carrot
Sweetness III	Medium length, relatively uniform

Discussion

The extended maturity time and cooler weather experienced toward the end of August resulted in improved flavour of the carrots. Although differences in flavours could not be quantified, some varieties tasted noticeably sweeter later in the season.

The Grade-A carrot weights were averaged and used to calculate an estimated yield for large scale and small market garden operations, as seen in Tables 4.4 & 4.5. The calculated output ignores losses during harvesting for carrots that are not Grade-A, or possibly damaged during the harvest. The estimated output also uses the recommended seeding rate of 5 cm between seeds and a row spacing of 30 cm. The yields reported in this trial were based on averages from the trial. As a result of hand seeding and insufficient thinning, high densities within the row may have reduced potential yields. More controlled seeding may allow for growth of larger Grade-A carrots, which would result in better total production. Also alternative rowing techniques would allow for a better utilization of the land and increased production per hectare without creating high density stresses.

The estimated yields per hectare for a large operation and the value per hectare were calculated using the 2006 Alberta Carrot FOB Market Prices Report from Agriculture and Agri-Food Canada as seen in table 4.4. For 2006 the carrots ranged from $13.50 to $16.00 for a 10 x 5lb unit in Alberta. Prices in Manitoba were higher in contrast to the big markets of Ontario, Quebec and British Columbia where the prices were lower. Traditionally, Yukon products come from Alberta distributors therefore an average Alberta price of $14.75 per 10 x 5lb unit or $0.65 per kg was used to calculate estimated value per hectare.

Table 4.4: Large scale operation outputs for each variety of carrot

	Estimate yield per hectare (tonnes/ha)	Value per hectare based on 2006 Alberta FOB price of $0.65/kg
Red Cored Chantenay	70.3	$45,698
Red Cored Denver	65.5	$42,620
Nantes Coreless	50.7	$32,995
Nantese Touchone	50.0	$32,496
Scarlett Nantes	47.5	$30,892
Little Finger	44.5	$28,941
Tender Long Imperta	43.8	$28,486
Mezza Lunga Nantes	42.9	$27,900
Tendersweet Long Hybrid	41.9	$27,228
Sweetness III	40.9	$26,600

One hectare of land was calculated to produce an estimated 40.9 to 70.3 tonnes of carrots. At $0.65/kg, would generate $26,600 to $45,698. Information from a British Columbia fact sheet "Planning for Profit" outlines the expense costs for a topped carrot operation. Using the projected expenses from this fact sheet as a base line and increasing the labour cost to $15 per hour, the projected expenses are approximately $9,400 per hectare. This would reduce the gross profit to between $17,200 and $36,500 per hectare.

A smaller operation, of 1,000 m^2 or a quarter of an acre was estimated to produce between 4,090 to 7,030 kg and at the Alberta FOB price would generate $2,700 to $4,600 as seen in table 4.5. If sold at the Fireweed Community Market, where prices are approximately $4.41/kg or $2.00/lb, the resulting income per 1,000 m^2 would range from $18,000 to $31,000 per 1,000 m^2. The $2.00/lb Fireweed Community Market price is an estimate value based on a survey of market gardeners. It should be noted that these market gardeners are organic producers.

Table 4.5: Small scale (1000 m^2) operation outputs for each variety of carrot

	Estimate yield per 1000 m2 plot (kg/1000 m2)	Value per 1000 m^2 based on 2006 Alberta FOB price of $0.65/kg	Value per 1000 m^2 based on $4.41/kg ($2.00/lb) Fireweed Market price
Red Cored Chantenay	7027	$4,569.91	$30,982.42
Red Cored Denver	6553	$4,262.07	$28,895.37
Nantes Coreless	5073	$3,299.52	$22,369.66
Nantese Touchone	4997	$3,249.66	$22,031.61
Scarlett Nantes	4750	$3,089.24	$20,944.00
Little Finger	4450	$2,894.13	$19,621.22
Tender Long Imperta	4380	$2,848.60	$19,312.57
Mezza Lunga Nantes	4290	$2,790.07	$18,915.74
Tendersweet Long Hybrid	4187	$2,722.87	$18,460.11
Sweetness III	4090	$2,660.00	$18,033.88

Information from "Planning for Profit" for organic operation outlines the estimated expense for smaller more labour intensive operations. Using the projected expenses from this fact sheet as a base line and adjusting the labour cost to $15 per hour and converting to 1,000 m^2, the projected expenses are approximately $2,500. Expenses of $2,500 can almost eliminate the profitability of an operation selling at an FOB price but at $2/lb profitability is only slightly affected.

Conclusion

The carrot evaluation proved that a profitable carrot production can be achieved for both a large and small scale operation. The level of profitability is largely dependent on the selling price that can be achieved for the carrots. The trial used a conservative FOB price for a large scale operation and a local Yukon product sold in this market may achieve higher margins that would result in better profits. For the small market garden operation the premium market price has some room for fluctuations as the market fills, nonetheless lower prices would still allow for good margins.

The information from the BC Ministry of Agriculture and Lands, Planning for Profits is available online at www.agf.gov.bc.ca/busmgmt/budgets/vegetables.htm.

5.0 FORAGE DEMONSTRATION

Location: Research Farm (Site RF), Whitehorse YT

Funding: Yukon Government

Objective: To assess the yield and hardiness of various forages species in south central Yukon conditions.

Introduction

Forage demonstration plots were set up in August 2005 at the Yukon Government Research Farm. A series of 24 plots were established on the south side of the Research Farm for a demonstration of various forage species in Yukon conditions.

Methods & Materials

The site is on a slightly shaded, flat aspect within the 1.5 ha cleared area of the research farm. Irrigation and fertilizer are applied to provide optimum conditions.

An overwintering assessment was carried out in the spring to quantify winterkill. The percent cover pace point intercept method was used to determine the percent cover and infer the rate of winterkill. A transect was delineated through the middle of each plot and the point of a bar was placed down randomly on the ground approximately every 0.5 meter. Walking through the plot from West to East and recording what the point of the bar contacted; weed grass/legume, bare ground or dead patch. If more than one contact is made, both are recorded. Each point is recorded and the percent of plant surviving in the stand is calculated. Above ground biomass yields were assessed throughout the season using a one square meter sample. Samples were harvested and placed in paper bags, dried at 40°C for 24 hours and weighed.

Results

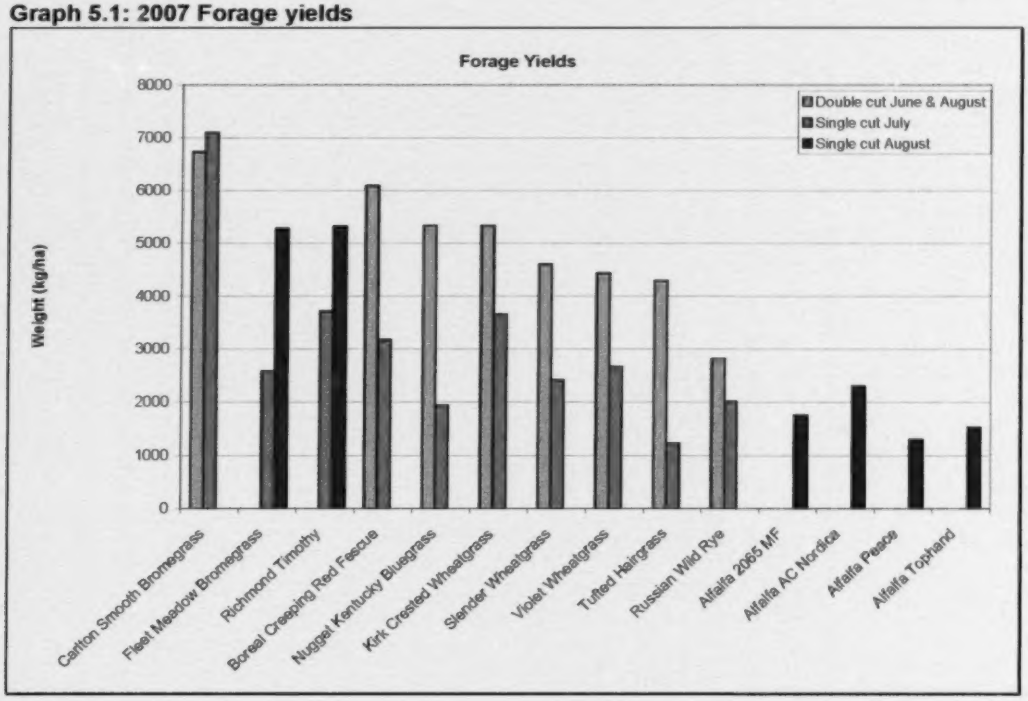
In 2007 only two forage plots had to be reseeded, reed canarygrass and orchardgrass, otherwise most grass demonstrations overwintered substantially better than last year. The exceptions were the legumes, the red clover did not survive and was not reseeded and a couple of the alfalfas died back substantially as well. Table 5.1 summarizes results from the percent cover assessment in the spring.

Table 5.1: Forage demonstration inferred winter survival

	Observations	Weeds	Grass	Bare	Dead	Winter Survival (%)
Carlton smooth bromegrass	20	0	10	10	0	50
Kirk crested wheatgrass	20	0	15	5	0	75
Fleet meadow bromegrass	20	0	13	7	0	65
Boreal creeping red fescue	20	0	9	7	4	45
Richmond timothy	20	0	14	1	5	70
Bellevue reed canary grass	20	11	2	7	0	10
AC Nordica alfalfa	20	5	0	14	1	0
2065 MF alfalfa	20	2	0	15	3	0
Ram red Clover	20	1	0	8	11	0
Peace alfalfa	20	4	3	5	4	15
Russian wildrye	23	9	14	3	0	61
Violet wheatgrass	24	17	8	1	0	33
Kentucky bluegrass	23	2	22	0	1	96
Tufted hairgrass	24	8	16	1	0	67
Slender wheatgrass	24	11	9	7	0	38
Okay orchardgrass	23	11	2	6	5	9

Yields were assessed for each plot that had enough growth to harvest and on three different harvests: a double cut, one June 29 and the other August 16; a single harvest July 19; or a single harvest August 16. Not all plots were harvested at all dates because some did not produce enough shoot biomass early in the season.

Graph 5.1: 2007 Forage yields



Discussion

Fourteen species remained in the demonstration for 2007. As expected the Carlton smooth bromegrass produced more than the other forages, both in a single or double cut system. Surprisingly the double cut smooth bromegrass did not produce more forage than the single cut. The yield of the smooth bromegrass is over 7 t/ha (2.8 t/acre) which is below average for a brome stand in irrigated, fertilized Yukon conditions. Some grasses responded very well to the double cut system, the Boreal creeping red fescue, the Nugget kentucky bluegrass, the slender wheatgrass and the tufted hairgrass all doubled in production under a 2 cut system, but still did not match the production of a single smooth bromegrass harvest. The legumes all performed relatively poorly, they were all reseeded in 2006 and were still establishing, the only bright light was AC Nordica which produced over 2 t/ha (0.8 t/acre).

Winterkill was assessed in early May using the percent cover method. As last year, the most successful overwintering grass was kentucky bluegrass (a perennial favourite for lawns), other grasses that faired well include crested wheatgrass, meadow bromegrass, timothy, russian wildrye, and tufted hairgrass. Although successful establishment was noted last August some of the species had to be reseeded because no plants survived. Orchardgrass and reed canary grass were reseeded.

Physical pulling of plants was used for weed control. The main problem species were hawksbeard and scorpion weed.

There was very limited disease incidence, the only concern continued to be smut on the slender wheatgrass, which has also moved over to minimally affect the violet wheatgrass.

6.0 OILSEEDS PRODUCTION POTENTIAL IN THE YUKON FOR BIODIESEL

Location: Research Farm (Site RF), Site SM, Site HN
Funding: Advancing Canadian Agriculture and Agri-Food ACAAF
Objective: To evaluate oilseed production in the Yukon

Introduction

In 2006 a research project was initiated to evaluate growing oilseeds in the Yukon as a feed stock for biodiesel a fossil fuel alternative. In this first year of the project the following questions were asked:

- Can oilseeds be grown in the Yukon?
- What oilseeds produce the best yields and total oil content?
- Which agricultural areas perform best?
- Is irrigation necessary?

Results showed that oilseeds can be grown in the Yukon. Four different oilseed crops were evaluated in 2006 with different levels of success. Of the four oilseeds evaluated, *Camelina sativa* and *Brassica rapa* canola showed the best maturity and yields. *Brassica napus* canola and Flanders flax were also evaluated in 2006, resulting in low yields in the *B. napus* and no maturing seed from the Flanders flax. Results from 2006 also showed that irrigation is a necessity, as production from dryland sites had limited to no maturity. The Agricultural area expected to have the highest yields was in the central Yukon, where the climate is warmer, unfortunately the crops at this site were lost due to unknown causes (suspicion is the nearby ground squirrels enjoyed them). The remaining locations were all in the Whitehorse area.

For 2007 the oilseeds evaluation was continued to further understand the potential of oilseeds for biodiesel. The following objectives were set out for 2007:

- Continued evaluation of oilseed production under irrigated conditions in the Whitehorse area
- Re-evaluated the potential of oilseeds in the central Yukon.
- Continue to evaluate the same 4 oilseeds crops utilizing the small plot randomized design method.
- Extend the evaluation of *B. rapa* to include an addition variety.

Note: No GMO crops were or will be tested under this project.

The 2007 trial eliminated any dryland trials, which reduced the trial locations to 2 sites in the Whitehorse area and one site in the central Yukon. The same oilseeds were evaluated for 2007 which included:

- *Camelina sativa* (False Flax, or Gold of Pleasure)
- *Brassica rapa* (Polish Canola)
- *Brassica napus* (Argentine Canola)
- *Linum usitatissimum* (Flanders Flax)

The evaluation of *B. rapa* was expanded to include two varieties because of it's good performance in 2006 and shorter maturing time. The Flanders flax was carried over to 2007, mostly to determine if the historically warmer central Yukon can mature flax and also to ensure that flax is not prematurely being eliminated from the evaluation.

Materials and Methods

The seed selection for 2007 was kept to the same four species as 2006 trial, with the addition of a second variety of *B. rapa*. The decision in 2006 was to evaluate the most suitable oilseeds for a cooler Yukon climate and included a long season *B. napus* canola, a short season *B. rapa* canola, a low input *C. sativa* and Flanders flax. Table 6.1 provides the detailed information for each of the oilseeds tested in 2007.

Table 6.1: Oilseeds evaluated

Common name	**False Flax (Gold of Pleasure)**	**Polish Canola**		**Argentine Canola**	**Flanders Flax**
Species	*Camelina sativa*	*Brassica rapa*		*Brassica napus*	*Linum usitatissimum*
Seed name/ variety	CN30476	SW Spirit River	Reward	6803-01	Flanders
Supplier	Crop Development Centre	Bonis & Co. Ltd	Mueller, Three Hills Alberta	HyTech Productions ltd	Se-Can Association
Breeder	Crop Development Centre, Saskatoon	Svalof Weibull Ltd	SeCan	DSV Canada	Crop Development Centre, Saskatoon

A germination test was conducted on the Spirit River *B. rapa* supplied for the trial and the 2006 Yukon grown seed. The Yukon grown *C. Sativa* was also tested for germination. From the germination test the Yukon grown seed was used for the *B. rapa* Spirit River and the *C. Sativa*.

The varieties selected were planted only on sites with irrigation that included 2 sites in the Whitehorse area (RF & SM site) and one site in the central Yukon (HN site).

Each site seeded a different mix of oilseeds with only 2 sites planting flax and the Reward variety of *B. rapa*. The flax was seeded in the central Yukon and at one site in the Whitehorse area. The new Reward variety of *B. rapa* canola was planted only in the Whitehorse area, as it was not available at the time of planting in the central Yukon. Table 6.2 outlines the seeds evaluated at each site.

Table 6.2: Summary of variety and species evaluated per site

	Site HN	Site RF	Site SM
C. sativa	✓	✓	✓
B. rapa cv Spirit River	✓	✓	✓
B. Rapa cv Reward		✓	✓
B. Napus	✓	✓	✓
Flanders flax	✓		✓

Each variety and species was randomly planted into plots, planting each variety 4 times per site. The plots are 2x2 meter in size with 0.5 meter buffer between each plot. Depending on the number of species and varieties planted, the site can have between 16 to 20 plots. The plot layout was set up using a measuring tape and survey markers. The plots were seeded at recommended seeding rates and adjusted if required depending on germination rates (for example if a variety had only 86% germination, the seeding rate would be increased by a factor of 1.16 to adjusted for this reduced germination). The seeds were planted in lines or furrows, drawn in the soil by a modified rake. The row spacing was set at 20 cm apart with 11 rows per plot. The seeding was done by hand into the furrows and each plot was raked and rolled after seeding.

Seeding rate:

- *Brassica* @ 8 kg/ha (equal to 3g for a 2x2m plot)
- *C. sativa* @ 5 kg/ha (equal to 2g for a 2x2m plot)
- Flanders flax @ 30 kg/ha (equal to 12g for a 2x2m plot)

Seeding depth: 1 – 2.5 cm

Table 6.3: Seeding dates

	Seeding Dates
Site HN	May 17/07
Site RF	May 16 &28*/07
Site SM	May 28/07

*Seeded *B. rapa* Reward

At each site composite soil samples were taken in the spring and sent out for testing to assess optimum fertilizer rates. Fertilizer was added according to the recommendation of Norwest Labs as outlined in table 6.4. The HN and SM sites were not identified as being irrigated, which changes the level of fertilizer required for these plots. Irrigated sites have higher expected yields and therefore require more fertilizer. The SM site may have received additional fertilizer than recorded when the neighbouring crop was fertilized.

Table 6.4: Fertilizer rate as reported by Norwest Labs

	Nitrogen		Phosphorus		Potassium		Sulphur	
Site	**lbs/acres**	**kg/ha**	**lbs/acres**	**kg/ha**	**lbs/acres**	**kg/ha**	**lbs/acres**	**kg/ha**
Site HN	80	90	40	45	59	66	0	0
Site RF	162	182	0	0	46	52	0	0
Site SM	99	111	0	0	26	29	32	36

At minimum monthly visits were made to each site to record presence of species, stage of growth, plant height, and pod stage. Climate monitoring was conducted at the RF and SM sites and obtained from a local weather station for the HN site. Climate data was collected to assess the growing season and heat units at each site.

The plants were harvested from each plot and bagged into large paper bags to be later thrashed and cleaned. A standard area of 1 m^2 was harvested by hand using trimmers and 1m^2 frame.

Table 6.5: Harvest dates

	Harvest Dates
Site HN	Sept 24/07
Site RF	Oct. 11/07
Site SM	Oct 10/07

The harvested plants were thrashed using a small seed thrasher. The thrashing separated the seeds from the plant stock or straw material. The separated seed required additional cleaning to remove broken pods, and small bits of the plant. The seed was cleaned using The Clipper Seed Cleaner/Separator from A.T.Ferrell & Co. The seed cleaner/separator separated the seed from the scrap material. Further cleaning was required at the lab to separate damage and immature seed that would not be collected using in a conventional combine harvester. The additional seed cleaning was done by the Saskatoon Research Centre lab, which also measured the oil and protein content of the oilseeds for each harvested plot.

Results

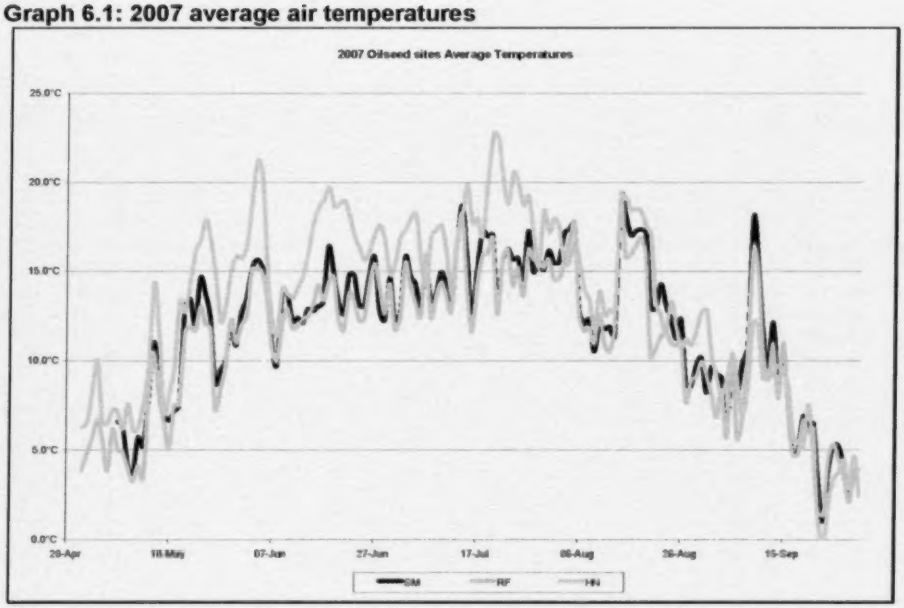
The 2007 growing season was an exceptional year in the central Yukon as indicated by the noticeably higher temperature observed at the HN site in Graph 6.1 compared to the sites in the Whitehorse area. The Whitehorse area had a normal climatic year with average temperatures and frosts. Table 6.6 summarizes the growing season. HN had an agroclimatic capability of class 1, due to the warmer summer and long growing season. The warmer HN site also experienced the most frost occurrences although a majority of the frosts occurred before plant emergence early in the season.

Table 6.6: 2007 Summary agroclimatic data at the oilseeds research sites

	RF	SM	HN
Sum of GDD	831	900	1296
Sum of EGDD	964	1043	1529
Start of growing season	18-May	16-May	26-Apr
End of growing season (first killing frost -2.2°C)	27-Aug	27-Aug	22-Sep
Agroclimatic capability class	Class 4	Class 3	Class 1
Number of frosts during growing season	20	9	23
Number of frosts experienced before July 15	16	7	19
Number of frosts experienced after July 15	4	2	4
Last Spring Frost	06-Jul	09-Jun	21-May
First Fall Frost	12-Aug	12-Aug	28-Aug

Photo 6.1: Test plot mid season at SM site.

Graph 6.1: 2007 average air temperatures



Monthly visits were conducted at each site to record presence of species, stage of growth, plant height, and pod stage. Most plots showed good emergence and growth through the season and Table 6.7 identified some of the significant observations during the season.

Table 6.7: Summary of significant observation during the growing season

	Observations
Site HN	• Excessive weed growth through the plot, competing with oilseeds. Extensive weeding in early July showed immediate impact and improved growth and maturity. • Lower germination in plots along the fence line, most affected is the Flanders flax with approximately 50% germination.
Site RF	• *C. sativa* from 2006 reseeded itself, and started to grow. The area with the reseeded growth was contained and turned into a low input evaluation. • Early evaluation showed low emergence in the *Brassicas*, with later germination increasing the emergence to 80 to 90%.
Site SM	• Early evaluation of the *B. rapa* cv Spirit River, 2 of 4 plots with low emergence, late germination increasing the emergence to 90%. • Volunteer oats through whole plot, extensive weeding conducted to reduce competition. • Spraying in July in the crop, noticeably knocked back Flanders Flax and one plot of *B. rapa* cv Spirit River • Poor germination in Flanders Flax.

In late September and early October 1 m^2 was harvested from each of the plots in all three locations. This was a late harvest as noted by the snow and the high incident of lodging and shattering. Photo 6.2 shows shattering in the *B. rapa* at HN, photo 6.3 shows the lodging and snow cover at the RF site prior to harvesting and Table 6.8 summarizes the observations during harvesting.

Photo 6.2: Pod shattering of *B. rapa* at HN

Photo 6.3: Lodging and snow cover at RF

Table 6.8: Harvest observations

	Observations
Site HN	• Light snow and ice cover, melting during the day. • Shattered pods in the *C. sativa*, seeds from shattered pods germinating , new plants at 2 leaf stage. • Poor establishment in the *B. napus*. Significant shattering throughout. • *B. rapa* cv Spirit River has good germination, strong stand which is easy to harvest. Some shattering. • Flanders Flax has poor germination, portion of plots knocked down by horses.
Site RF	• Heavy snow covering at time of harvest. • *B. napus* poor establishment, good strong stocks, no lodging easy to harvest. • *B. rapa* cv Reward plots significant lodging and shattering in plots. • *B. rapa* cv Spirit River strong stems, less lodging and easy to harvest.
Site SM	• Heavy snow covering plants. • Some shattering noticeable in *C. sativa*. • *B. napus* plots approximately 50% mature with noticeable shattering in mature plants • *B. rapa* cv Reward plots matured with lots of lodging and shattering of pods. • *B. rapa* cv Spirit River plots stronger stems, less lodging but because of maturity has significant shattering. • Harvested only one plot of flax, due to the poor maturity of the plots. The most matured plot was harvested. • Flax is not completely matured.

The weight of the harvested seed was used to calculate average yields per hectare at each site (Table 6.9). The Saskatoon Research Centre lab further cleaned the samples as noted by the weight difference for clean seed. The further cleaning at the lab, was required to obtain a representative sample of a large scale combine harvest. The additional cleaning removed immature and damaged seed that would normally get blown out the back of large scale combines. The lab analyzed the samples with near infra-red (NIR) technology to determine percent oil and protein (Table 6.10).

Observations during seed cleaning found the *C. sativa* from site to site was most consistent in seed size and uniformity as noted by the minimal cleaning required at the lab (noticeable in the small difference between the original weight of harvest vs. clean harvest weighs table 6.9). The *Brassica* seeds were found to have less uniformity and more damaged or immature seeds, also observed by the increased difference in clean vs. original seed weights in table 6.9. The quality of the *B. napus* was observed to be poorest and was verified by the lab results, as noted by the difference in harvest weights per hectare before and after cleaning.

Table 6.9: Average harvested values for each variety harvested at each site

		Original harvest	Clean seed (extra cleaning by lab)		
Site	Oilseed	Total Harvest (t/ha)	Total Harvest (t/ha)	Total Oil (t/ha)	Total Protein (t/ha)
HN	*Camelina sativa*	2.18	2.11	0.94	0.53
RF	*Camelina sativa*	1.75	1.46	0.63	0.37
SM	*Camelina sativa*	1.65	1.46	0.61	0.39
HN	*Brassica napus*	0.97	0.24	0.11	0.05
RF	*Brassica napus*	0.80	0.25	0.09	0.06
SM	*Brassica napus*	1.28	0.33	0.15	0.08
HN	*Brassica rapa* (Spirit River)	1.25	0.70	0.32	0.17
RF	*Brassica rapa* (Spirit River)	1.75	1.20	0.59	0.24
SM	*Brassica rapa* (Spirit River)	1.07	0.51	0.24	0.12
RF	*Brassica rapa* (Reward)	1.47	0.60	0.26	0.14
SM	*Brassica rapa* (Reward)	0.90	0.53	0.23	0.13
HN	*Linum usitatissimum* (Flax)	0.91	0.72	0.31	0.16
SM	*Linum usitatissimum* (Flax)	0.83	0.63	0.25	0.16
RF	Low Input *Camelina sativa*	0.98	0.92	0.41	0.22

The oil content of each of the species and varieties averaged between 41.8 to 46.7%, with the *B. rapas* having the highest oil content followed by the *C. sativa* as shown in Table 6.10. The *C. sativa* was found to have highest average percentage of protein, although the range for the entire test was relatively narrow, ranging between 23.3 to 25.7% protein.

Table 6.10: NIR results of oil and protein content

	Oil (%)			Protein (%)		
Oilseed	Average	Min	Max	Average	Min	Max
Camelina sativa	43.0	40.7	45.2	25.7	23.9	27.6
Brassica napus	41.8	32.2	47.7	23.7	22.0	26.2
Brassica rapa cv Reward	44.4	43.2	46.3	23.3	21.9	24.1
Brassica rapa cv Spirit River	46.7	43.6	52.2	22.5	17.2	25.1
Linum usitatissimum (Flanders Flax)	41.8	39.8	43.7	24.6	22.9	26.3

Discussion

Results continue to show that oilseeds can be grown and matured north of 60°. The *Camelina sativa* is performing well at all sites, producing between 1.46 to 2.11 t/ha of seed and 0.61 to 0.94 t/ha of oil. The *C. sativa* has been the best performing oilseed based on total yield, oil and protein per hectare as shown in Graph 6.2.

Graph 6.2 shows the average production for each species and variety planted at each location. The dash line - - - - - - - - - - - in the graph indicates the expected yields for each of the species. The expected yield for *C. sativa* is defined by Camelina Canada as 1.34 to 2.60 t/ha. An expected yield for canola is based on yearly canola production data from the Prairie Provinces from 1986 to 2006 and ranges from 0.86 to 2.10 t/ha. Yields reported for flax in 05, 06 and 07 from Agriculture Canada Flaxseed Supply and Disposition ranged from 1.52 to 1.83 t/ha. The canola and flax ranges include the lowest and highest production years.

The *Brassicas* on average are performing below expectations, with yields below the values reported for canola production from 1986 to 2006. Although the *B. rapa* cv spirit river is showing signs of having average production results, as indicated by the results from the RF site. The RF site was the only site to receive a higher irrigated fertilizer rate which may result in an increase level of production. The other two sites received lower dryland fertilizer rates that would reduce potential yields.

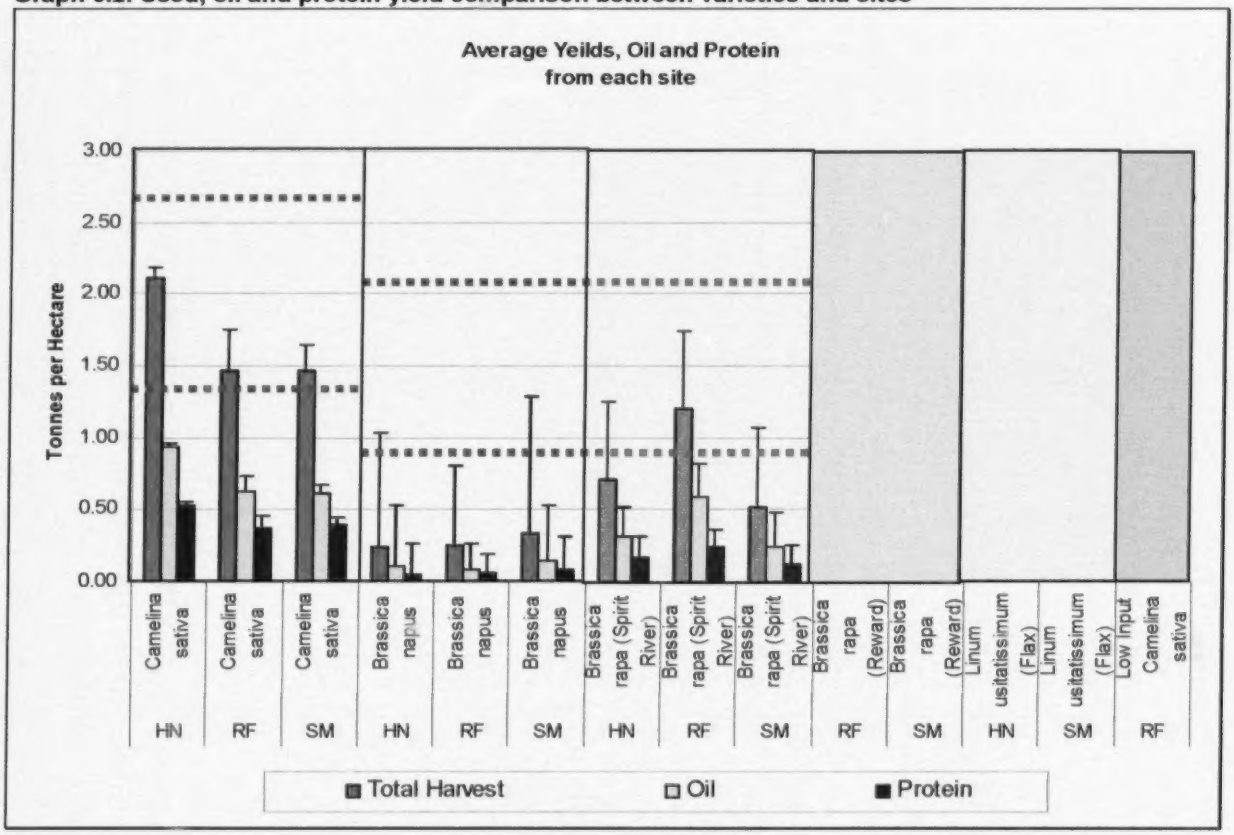
The *Brassicas* at all sites and the *C. sativa* at the HN site were observed during harvest to have varying levels of shattering and seed lost due to the late harvest, this would also reduce yields, although the level of shatter was not quantified therefore it is difficult to determine the exact lost, but indicates there maybe some increased yields with an earlier harvest before shattering.

All the *Brassicas* required additional cleaning in the lab as did the *C. sativa* to a lesser degree. The additional cleaning removed any unwanted material originally harvested. The original harvest is indicated by the top of the "T" in the graph. There is a larger difference in the *Brassicas* because of a significant amount of immature seed that was originally harvested and separated out by the lab. The larger the difference between the bar and the top of the "T" indicates a higher level of immature seed and the *Brassicas* are not reaching full maturity.

The Flanders flax reached marginal maturity in 2007as observed from poor yields well below Agriculture Canada 2005 to 07 yield reports. The HN site showed slightly higher yields, and visually was more mature and uniform in size and colour. Horses pasturing in the field at HN knocked down some of the flax resulting in yield loss, although not quantified. Both sites showed better than expected production.

An impromptu low input trial was conducted at the RF site with the *C. sativa* as a result of the plant reseeding itself during plough down in the spring. The *C. sativa* was allowed to grow, with little to no input (i.e. no irrigation or fertilization). A $1m^2$ area was harvested in the fall and the cleaned seed weighed and sent to the lab for analysis. The impromptu trial produced 0.98 t/ha, which is a lower yield compared to the fertilized and irrigated *C. sativa* trial at the site. The seeding density was not determine but was observed to be low, and the plants did not grow to the same height as the fertilized trial. There was no observed difference in percent oil and protein in the seed. The trial indicates that C. sativa does mature under low input, dryland conditions.

Graph 6.2: Seed, oil and protein yield comparison between varieties and sites



Conclusion

In 2007 it was proven that oilseeds do mature in the Yukon and the *C. sativa* was again the best performer. The *C. sativa* produced between 1.65 to 2.18 t/ha, which would equate to 610 to 807 litres of biodiesel per hectare based on using a small scale press biodiesel plant. At a price of 1.20 per litre for vehicle diesel the crop can generate $732 to $978 per hectare for the fuel. The oil is not the only component of the crop with value, the meal or byproduct of pressing the oil can be used as animal feed; with an average price from the last 3 years of $162 per tonne (based on canola meal prices from the Canola Council FOB Vancouver prices).

The impromptu trial of the *C. sativa* under low input conditions shows that there are options in seeding, irrigation and fertilization management. The low input *C. sativa* matured without being directly seeded, no fertilizer added and no direct irrigation. Additional work maybe required to investigate a winter seeding of the *C. sativa* to take advantage of spring moisture, and to further determine this crops potential in dryland conditions.

Early snowfalls and a late harvest of the oilseeds may have reduced yields, as shattering was observed in the crops, especially in the *Brassicas*. The oilseed evaluation is scheduled for two more years and will require a better scheduled harvest to further understand if improved yields can be achieved.

7.0 POTATO SEEDING DEPTH AND FERTILIZER TREATMENT EVALUATION AND RED POTATO VARIETY COMPARISON

Location: Site RF (Research Farm) and SM (Steve Mackenzie)

Funding: Yukon Government, APF Science and Innovation

Objective: To determine optimum seeding depth for potatoes planted in cooler soils, and to determine the effects of fertilizer timing on total production.

Introduction

This trial was conducted to determine optimum seeding depth for potatoes planted in cooler soils, and to determine the effects of fertilizer timing on total production. Soils generally get cooler with depth and the purpose of the seeding depth trial was to evaluate if shallower seeding in warmer soil would result in earlier plant develop and better production. The fertilizer trial evaluated the application of fertilizer as a traditional single application versus splitting the same amount of fertilizer and applying the second half at a later stage of plant development to increase tuber growth. Each of the trials was conducted with two red varieties of potatoes as a variety comparison.

Materials and Methods

Two locations in the Whitehorse area were used for the potato evaluations. The RF site located near the junction of the Takhini and Yukon River evaluated the effects of seeding depth on production as well as a variety comparison. The SM site located just south of Lake Laberge evaluated the effects of seeding depths, fertilizer treatments, as well as a variety comparison.

The RF site was divided into 6 rows, of approximately 5.0 m in length and 1.0 m apart. The potatoes were seeded at a rate of 1 seed potato per 30 cm. Two varieties of potatoes were evaluated, at 3 different seeding depths as defined in Table 7.1. The 0 cm seeding depth was covered with straw to give the potato some cover from the sun and insulation. The potato variety evaluation was done between two red potatoes, the Norland and Red Pontiac varieties. The potato varieties used were from McKenzie seeds and purchased from a local garden centre in Whitehorse. The required fertilizer as determined from soil analysis for this site was applied in a single application on June 11th.

Table 7.1: RF Potato Plot set up

Row	Potato Variety	Seeding depth
1	Red Pontiacs	0 cm with Straw Cover
2	Red Pontiacs	5 cm depth
3	Red Pontiacs	10 cm depth
4	Norland	0 cm with Straw Cover
5	Norland	5 cm depth
6	Norland	10 cm depth

The SM site was divided into 8 rows, 10 m long with 1 m spacing between rows. Each row was seeded at a rate of one seed potato per 30 cm. The Norland and Red Pontiac varieties of red potatoes were evaluated at two seeding depths (5 cm and 10 cm) and included two fertilizer treatments. The total plot area was 80 m^2 (Table 7.2 gives an outline of the plot design). The fertilizer treatment was split, with treatment 1 on the north side and treatment 2 on the south side of the plot (1.74 kg of urea was applied based on soil analysis). Treatment 1 fertilizer was applied as a one time application on June 12. Treatment 2, the fertilizer was applied as a split fertilizer application with 50% of the fertilizer applied on June 12 and the remaining 50% applied June 29.

The Norland and Red Pontiac seed potatoes for the SM site were from Edmonton Potato Growers Ltd.

Table 7.2: SM site plot setup

Row	South (A) Fertilizer Treatment 2		North (8) Fertilizer Treatment 1	
	Potato Variety	Seeding Depth	Potato Variety	Seeding Depth
1	Red Pontiac	5 cm	Red Pontiac	5 cm
2	Red Pontiac	10 cm	Red Pontiac	10 cm
3	Norland	5 cm	Norland	5 cm
4	Norland	10 cm	Norland	10 cm
5	Red Pontiac	5 cm	Red Pontiac	5 cm
6	Red Pontiac	10 cm	Red Pontiac	10 cm
7	Norland	5 cm	Norland	5 cm
8	Norland	10 cm	Norland	10 cm

During the season the two sites received regular irrigation and weeding. The rows were hilled as the plants emerged, and evaluations on plant and tuber growth were conducted during the season. The potatoes were harvested by hand in September. At the RF site 10 plants per row were harvested. At the SM site 5 plants were harvested from each section. All harvested potatoes were washed, sorted and weighed. The potatoes were sorted into 6 categories. The categories included potatoes with no scab, potatoes with scab, and exposed potatoes. The good potatoes and scabbed potatoes were further sorted into subcategories based on size. The sizes ranged from small (< 5 cm diameter) to medium (5 to 10 cm diameter) and large (> 10 cm diameter). Extremely small potatoes of less than 2 cm in diameter were discarded. The sorted potatoes were then tallied and weighted as reported in Tables 7.3 and 7.4 of the results.

Results

At the RF site, the 0 cm seeding depth with the straw cover was observed to have poor to no growth. The other seeding depths (5 and 10 cm) at the RF site showed good plant growth. Observations during the season showed good tuber development. The data at the RF was collected from 10 plants, but was cut in half to report yields from 5 plants (Table 7.3), consistent with the data collected from the SM site. The exposed potatoes were not included in the totals, although reported to determine the effects of seeding depths on the incident of exposed potatoes.

Table 7.3: Potato yields based on variety and seeding depth (data split between number of potatoes and weight)

Potato:	Seeding Depth:	Fertilizer Treatment:		Small <5cm	Med. 5-10 cm	Large >10 cm	Small Scab <5 cm	Med. Scab 5-10 cm	Total minus exposed	Exposed Potatoes
Norland	0 (straw)	One application	Number of Potatoes	17	39	1		2	58	2
Norland	5 cm	One application		15	55	2	14	8	93	7
Norland	10 cm	One application		15	69	2	2	2	88	1
Pontiac	0 (straw)	One application		20	19		1	4	43	3
Pontiac	5 cm	One application		21	67	1	2	3	93	6
Pontiac	10 cm	One application		19	53	2	2	5	80	1
Norland	0 (straw)	One application	Harvest Weight (g)	657	4154	305		178	5293	79
Norland	5 cm	One application		442	6552	448	1704	210	9354	695
Norland	10 cm	One application		547	8348	459	150	239	9742	98
Pontiac	0 (straw)	One application		687	2046		15	505	3252	83
Pontiac	5 cm	One application		788	9973	341	86	237	11424	345
Pontiac	10 cm	One application		791	8200	581	68	838	10477	74

At the SM site observations during the growing season showed good plant and tuber growth. During harvest it was observed the incidence of Rhizoctonia and Powdery Scab was higher at the SM site. Results are reported in Table 7.4.

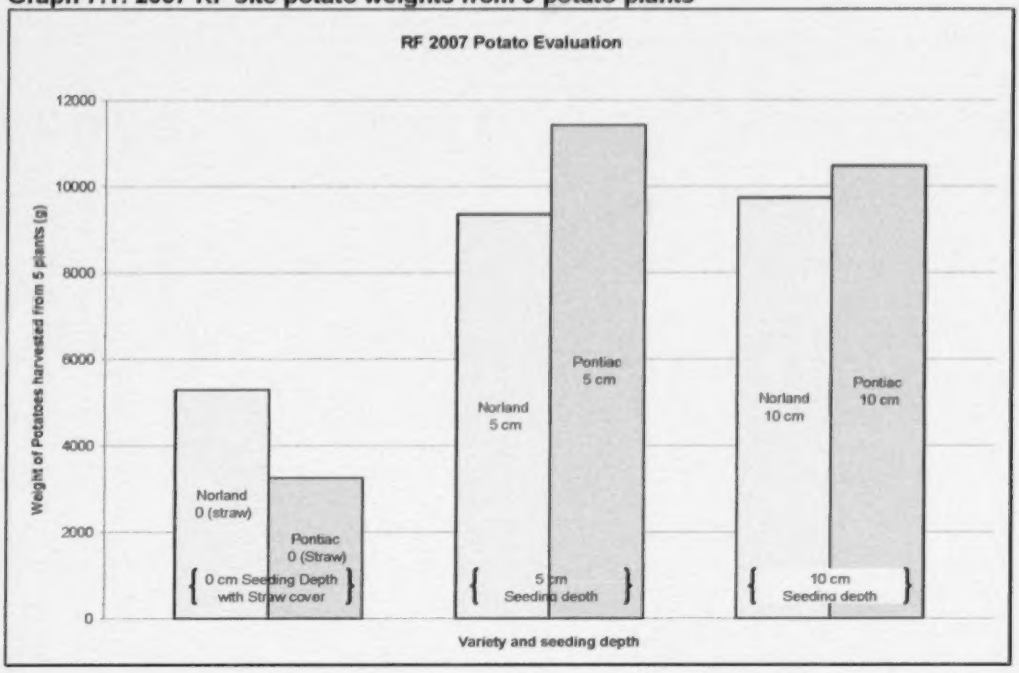
Table 7.4: Potato yields based on variety, seeding depth and fertilizer treatment (data split between number of potatoes and weight)

Potato:	Seeding Depth:	Fertilizer Treatment:		Small <5cm	Medium 5-10 cm	Large >10 cm	Small Scabbed <5 cm	Medium Scabbed 5-10 cm	Total minus exposed	Exposed Potatoes
Norland	5 cm	One application	Number of Potatoes	24	29		21	17	91	9
Norland	5 cm	One application		20	34		25	16	95	10
Norland	**5 cm**	**Split application**		**13**	**15**		**48**	**20**	**96**	**9**
Norland	**5 cm**	**Split application**		**18**	**18**		**31**	**24**	**91**	**16**
Norland	10 cm	One application		25	9		29	13	76	11
Norland	10 cm	One application		24	26		31	11	92	1
Norland	**10 cm**	**Split application**		**6**	**4**	**1**	**42**	**32**	**85**	**4**
Norland	**10 cm**	**Split application**		**13**	**10**		**47**	**20**	**90**	**1**
Pontiac	5 cm	One application		17	32		20	14	83	5
Pontiac	5 cm	One application		28	39		4	15	86	10
Pontiac	**5 cm**	**Split application**		**18**	**27**		**7**	**9**	**61**	**2**
Pontiac	**5 cm**	**Split application**		**12**	**22**		**28**	**11**	**73**	**0**
Pontiac	10 cm	One application		34	40		8	3	85	5
Pontiac	10 cm	One application		20	35		16	7	78	7
Pontiac	**10 cm**	**Split application**		**25**	**25**		**14**	**7**	**71**	**7**
Pontiac	**10 cm**	**Split application**		**8**	**13**		**29**	**29**	**79**	**0**
Norland	5 cm	One application	Harvest Weight (g)	1065	3246		831	1830	6972	619
Norland	5 cm	One application		866	3620		636	1565	6687	815
Norland	**5 cm**	**Split application**		**518**	**1936**		**1485**	**2234**	**6173**	**734**
Norland	**5 cm**	**Split application**		**881**	**2323**		**1101**	**2961**	**7266**	**668**
Norland	10 cm	One application		853	1335		888	1839	4915	783
Norland	10 cm	One application		1071	2872		1292	1000	6235	15
Norland	**10 cm**	**Split application**		**242**	**432**	**391**	**1492**	**3586**	**6144**	**191**
Norland	**10 cm**	**Split application**		**587**	**1067**		**1666**	**2210**	**5530**	**23**
Pontiac	5 cm	One application		812	4298		610	1403	7123	443
Pontiac	5 cm	One application		952	5142		1537	2211	9842	677
Pontiac	**5 cm**	**Split application**		**1007**	**3965**		**312**	**997**	**6281**	**236**
Pontiac	**5 cm**	**Split application**		**611**	**3122**		**959**	**1471**	**6162**	**0**
Pontiac	10 cm	One application		1909	5024		329	369	7631	220
Pontiac	10 cm	One application		701	4155		631	1125	6613	235
Pontiac	**10 cm**	**Split application**		**463**	**1869**		**978**	**3704**	**7013**	**0**
Pontiac	**10 cm**	**Split application**		*135*	**3667**		**651**	**832**	**5285**	**600**

Discussion

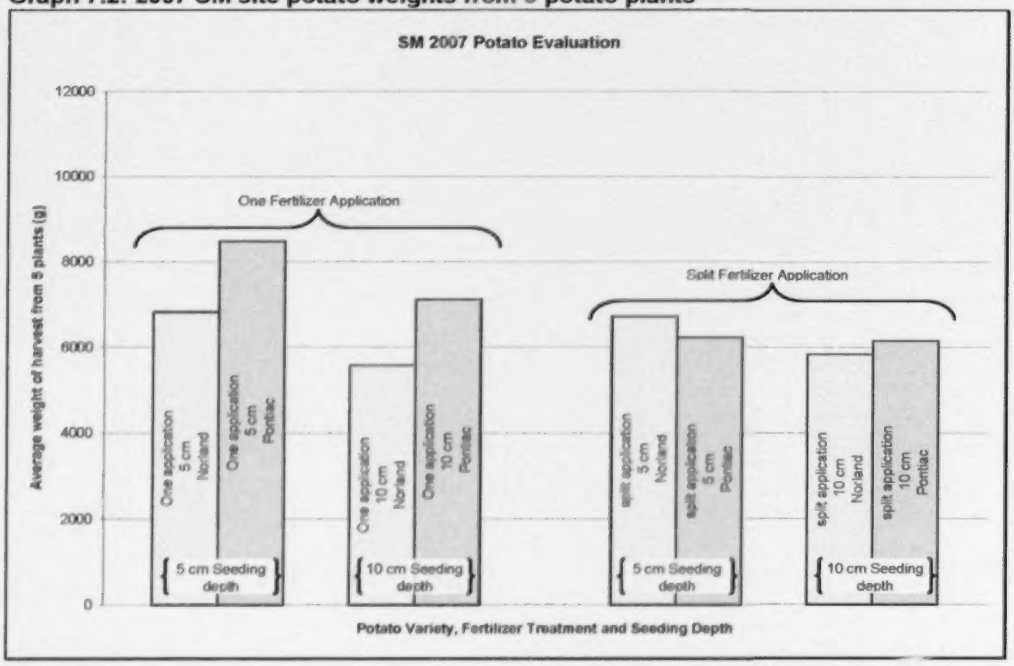
The data collect from RF site found that the 0 cm seeding depth with straw cover showed poor growth. Yields from this treatment were significantly different from the 5 and 10 cm seeding depth results as shown in Graph 7.1. Excluding the poor yielding 0 cm potatoes, the Red Pontiacs at the 5 and 10 cm seeding depth were slightly higher yielding compared to the Norland as shown in Graph 7.1. The graph also indicates that there were different responses from the potato varieties to the seeding depth. The Red Pontiacs at the 5 cm depth showed slightly increased yields for weight and numbers of potatoes. The Norland appear to have a reverse response to the seeding depth, as the potatoes from the 10 cm seeding depth had a higher total weight. Although the weight of the Norland were higher at the 10 cm seeding depth, the number of Norland potatoes harvested at the 5 cm depth was greater. Both varieties responded to the shallow seeding depth of 5 cm, which allowed for more hook and tuber development. The Norland at the 10 cm seeding depth, which had lower numbers of tubers, had larger tubers, and exceeded the total weight achieved from the 5 cm depth with more potatoes. Where as the Red Pontiacs at 5 cm generated more tubers and higher bulk weights, although the average weight of the medium sized potatoes, those that you would market as table potatoes, was lower.

Graph 7.1: 2007 RF site potato weights from 5 potato plants



At the SM site each evaluation was duplicated but when graphed individually that data was difficult to read due to the variability and low level of difference between the results. The data presented in Graph 7.2 is based on the average of the paired tests. The graph shows that the Red Pontiacs with the single fertilizer treatment had the highest harvested weights. The one fertilizer application resulted in higher harvest weights for the Red Pontiacs. For the Norland there was very little difference between the fertilizer rates. The Red Pontiacs at the 5 cm depth produced bigger potatoes and higher yields, in addition with higher yields found for the one fertilizer application than the split application.

Graph 7.2: 2007 SM site potato weights from 5 potato plants



Conclusion

The two sites had some similarities in responses to trial parameters, but also showed contradicting responses in other areas of the evaluation. The Red Pontiac potatoes were found to produce better than the Norland at both sites and the Red Pontiacs also showed more of a response to the shallow seeding depth with higher yields at both sites. The Norland potatoes showed no preference to seeding depth as observed by the contradictory response to seeding depth between the two sites. The fertilizer application trial at the SM site showed an obvious response to the single application fertilizer treatment in the Red Pontiacs, and no significant difference in fertilizer application with the Norland. Therefore it could be concluded the extra step of a split fertilizer treatment would not be beneficial. The Norland were found to be of a larger size at the RF site at the 10 cm depth but this was not repeated at the SM site, so the evidence that planting at the deeper depth would result in larger sized potatoes is mixed. The higher yields shown in the Red Pontiacs was the only distinct observation in the trial although there still the question of potato preference. Generally the Red Pontiacs have a deep eye sets compared to the Norland, which makes them less attractive and more difficult to wash.

8.0 RASPBERRY INPUT MANAGEMENT AND ECONOMICS OF PRODUCTION TRIAL

Location: Research Farm (Site RF), YT
Funding: Yukon Government, APF Science and Innovation
Objective: To employ best management practices around orchard production and determine the economics of raspberry production in the south central Yukon.

Introduction

This trial is the result of work initiated in 2002 with collaboration from the Pacific Agri-Food Research Centre in Summerland, BC. The purpose of the trial is to examine best management practices for fertilizing and irrigating for Yukon orchard crops. The goal was to apply only as much water and fertilizer as is needed. This not only conserves water resources, but it reduces the cost of production and risk of nitrate leaching. In addition, the trial looked at:

- Variety difference
- The economics of raspberry production
- Evaluating a row cover to lengthen the season.

Materials and Methods

The key to optimizing water use is to have a clear understanding of how much moisture is used by the plant, how much is transpired through the leaves and how much is lost through the soil. Water is automatically delivered using a CR-10 computer system which uses data from soil moisture and evapotranspiration (ET) sensors. The CR-10 controls the water delivered through a drip irrigation system to the orchard, and it only requires occasional manual involvement primarily during setup. The CR-10 and drip irrigation system was initiated June 12.

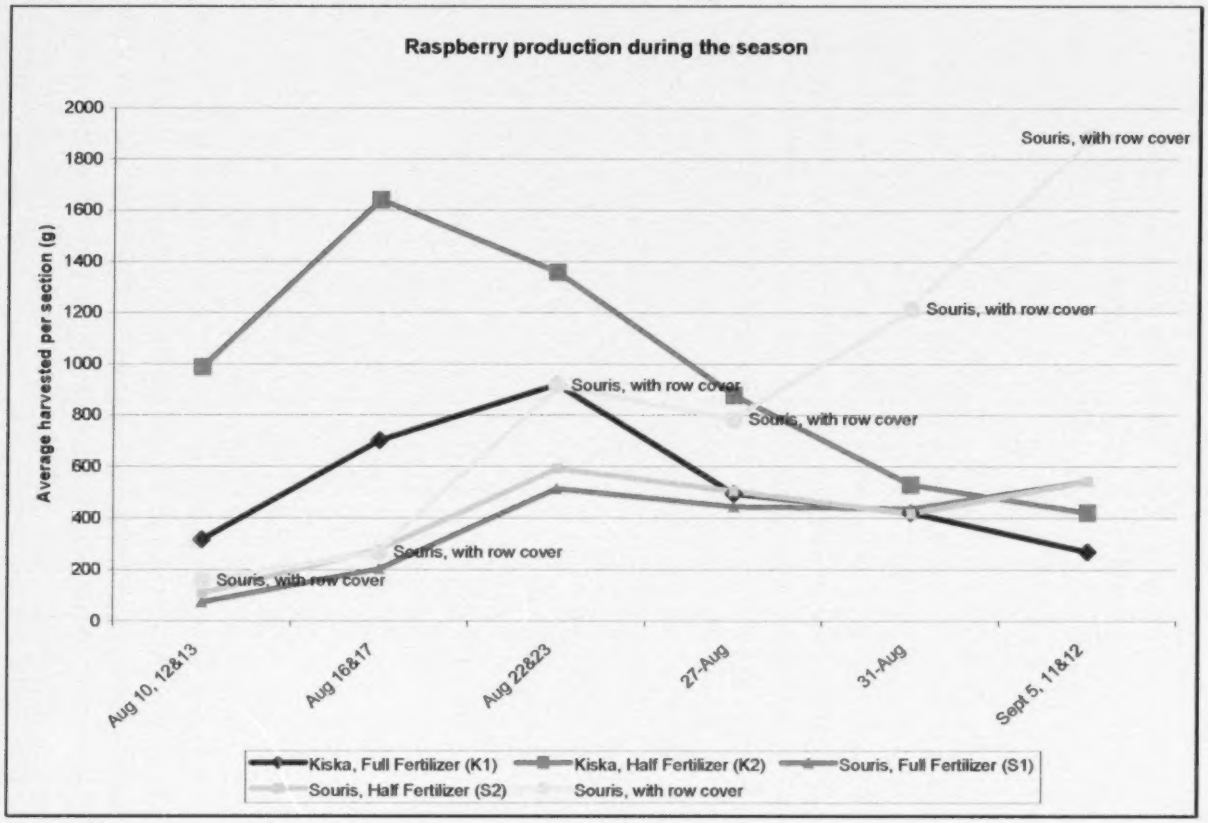
The raspberry orchard was established at the Research Farm in 2002 and took until 2005 before the orchard reached maturity producing a meaningful harvest. Work on the orchard began as soon as the snow melted in early May of 2007, with thinning, pruning, and trellising of the rows. Pre-emergent herbicide Princep-9T applied in 2005 has reduced weed growth within the rows, where cultivation would not be possible after the canes flushed. Cultivation to knock back sucker growth and weeds was conducted once in 2007 between the rows.

Fertilizer was applied through the drip irrigation system at the recommended rate from tank 1 and half the recommended rate from tank 2. In total 5.4 kg of $CaNO_3$ and 6,825 gallons of water was applied from tank 1 at the full fertilizer rate and 2.4 kg $CaNO_3$ and 5,350 gallons was applied at the half fertilizer rate from tank 2. Diagram 1 in the appendix shows the fertilizer treatment and variety distribution through the raspberry plot. The varieties are planted in sections, with a majority of the sections being planted to, or have grown into Souris/Boyne and the remainder planted to Kiska. The Kiska is an Alaskan developed variety with a medium size fruit and very tall canes. The Souris/Boyne is more of southern variety of raspberry with a larger berry, more in line with an eating berry. A row cover or portable greenhouse was built in 2007 and applied to 2 sections of raspberries for 2 weeks in late August to help extend the season.

Results

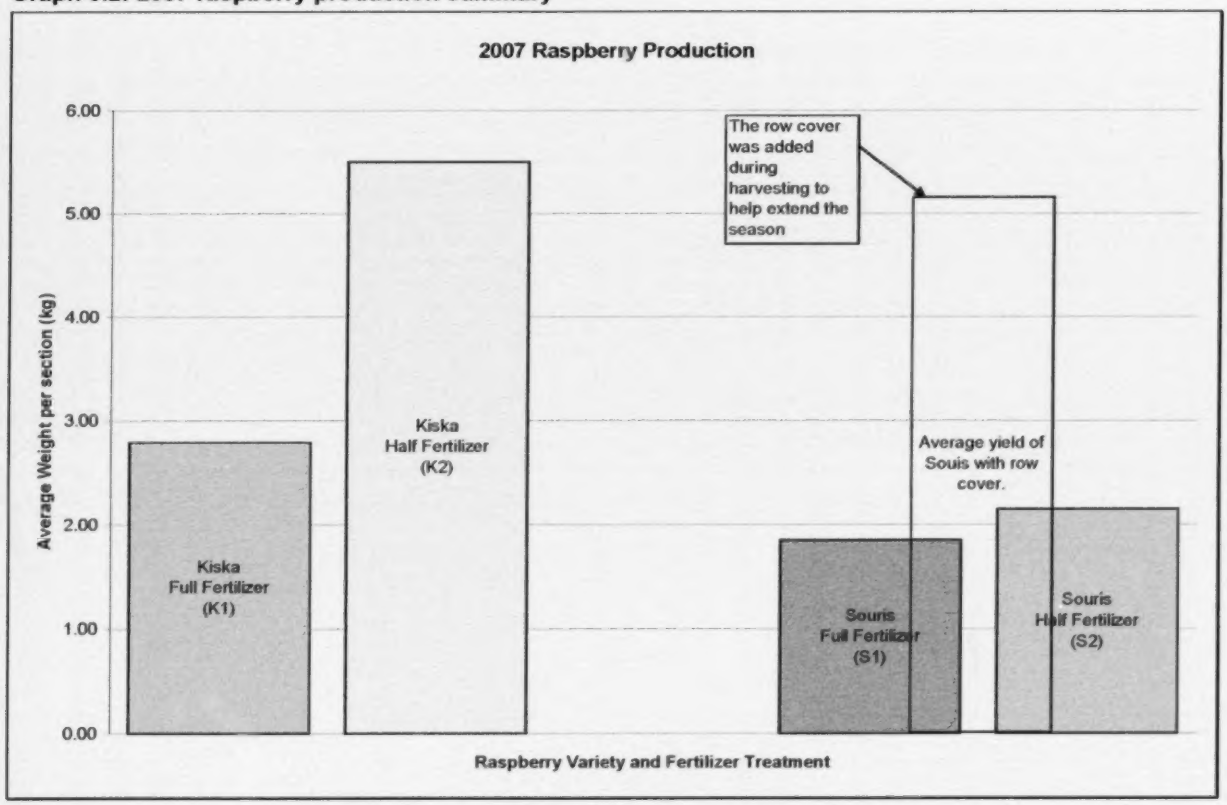
This was the third year the raspberry orchard produced a harvestable crop which allowed for an assessment of the economics of raspberry production. Production is evaluated on a per section bases, with four sections per row. The plot is 30 meters (100 feet) long by 40 m wide, divided into 12 rows with 4 sections per row, approximate area of the plot, minus the buffer rows is 1000 m^2. Total harvest for the site was over 100 kg. Harvest began on August 10, and the last harvest was September 11 and 12. Graph 8.1 shows the harvest totals on each of the picking dates. During 2007 the framed row cover was added late in the season to sections 21 and 22 also shown in the graph.

Graph 8.1: Raspberry production per harvest data and variety



Graph 8.1 shows that the Kiska variety of raspberries ripened earlier and peak harvest was between August 16 and August 27. The Souris raspberries ripened later in the season with peak harvest dates on August 22 to September 12. The row cover added to sections 21 and 22 helped extend the season and allowed the 2 sections to ripen into September. The row cover would have protected the raspberries from the frost occurrences which started in the middle of August and a killing frost on August 27. These frost occurrences slowed down the production of the raspberries, although the Souris was able to recover slightly as seen by the increase in production on the final harvest date.

Graph 8.2: 2007 raspberry production summary



The average production of raspberries per section is outlined in Graph 8.2. From this graph the Kiska raspberries are a higher producing variety compared to the Souris raspberries. Producing on average per section 2.8 to 5.5 kg compared to the Souris which produced on average between 1.9 to 2.2 kg per section depending on the fertilizer treatments. The fertilizer treatments showed that lower fertilizer rates produced more fruit (on average production weights were higher for the half fertilizer). There was less of a difference between productions found in the Souris variety compared to the Kiska. The Kiska with the half fertilizer treatment produced on average 5.5 kg per section vs. the full fertilizer treatment which only produced 2.8 kg per section.

Table 8.1: Tabulated raspberry production for 2007 based on variety and fertilizer treatment

	Average weight (kg)	Min (kg)	Max (kg)	Standard deviation
Kiska, Full Fertilizer (K1)	2.8	1.7	4.5	1.3
Kiska, Half Fertilizer (K2)	5.5	4.5	6.7	0.9
Souris, Full Fertilizer (S1)	1.9	0.8	3.7	1.0
Souris, Half Fertilizer (S2)	2.2	0.9	3.9	0.8

This data excludes sections 21, 22, 23, 24, 20, 34, 4, 13
The row cover on rows 21 & 22 averaged 5.2 kg for Souris

The Souris raspberries with portable row cover produced an average of 5.2 kg per section compared to 1.9 to 2.2 kg without row cover. The row cover allowed the raspberries to continue to ripen vs. the raspberries without row cover. The row cover was not available until later in the season and it will be interesting to see the effects the row cover will have during the 2008 season, when applied at the start of the growing season.

Discussion

The 2007 total raspberry production was a record harvest for this plot, with a total of 107 kg harvested. This harvest was compared to data provided by the British Columbia Ministry of Agriculture Factsheet on Planning for Profit (http://www.agf.gov.bc.ca/berries/factsheets.htm#top) and utilizing prices derived from BC berry and nut production values from the BC Ministry of Agriculture, Food and Fisheries - Horticultural Statistics. A Yukon price was developed to represent the extra value that can be fetched for fresh Yukon grown product sold at the Fireweed Community Market. The prices are as follows:

- $3.30/kg ($1.50/lb) represents an estimated whole sale price
- $6.60/kg ($3.00/lb) represents a BC roadside price or a Yukon u-pick price
- $9.90/kg ($4.50/lb) represents a Yukon grown, fresh market price

1 hectare = 2.5 acres
1000m^2 = ¼ acre
1kg = 2.2 lbs

The estimated income per hectare is calculated with the 3 different price ranges minus expense. Tables 8.3 and 8.4 summarize the 2007 yields, along with the income per hectare. Table 8.2 shows two largely different expense costs and is based on the expenses tallied from the Yukon operation vs. what was calculated using the formula from the BC fact sheet, therefore this changes the profit margin per hectare.

The Yukon expenses were extremely different to the BC expenses, this difference created some concern and loss of confidence between both calculated expenses. The BC fact sheet data was adjusted to account for:

- inefficiencies in picking in low yield orchards
- inefficiencies in pruning cost in smaller operations
- higher Yukon labour costs

Even with the adjustments against the BC fact sheet the Yukon expenses were still over 3 times higher.

Table 8.2: Comparison of expenses per hectare base on Yukon tabulated man hours vs. BC Fact Sheet expenses.

	Yukon Expenses		BC Fact Sheet Expenses	
	Time	Cost @ $15.00/hr per hectare	Expense rates	Cost per hectare
Pruning & Trellising	485	$7,275.00	$1,.779/hectare ($360/acre x 2)*	$1.779.12
Weeding	60	$900	$247/hectare ($100.00/acre)	$247.10
Irrigation		-	$124/hectare ($50/acre)	$123.55
Harvesting	1070	$16,050.	$3.97/kg ($0.3/lbx6)**	$4,246.06
Packaging		-	$0.75/kg ($0.17/lbx2)***	$802.03
Total expenses		$24,225.00		$7,197.86

*adjusted to represent less experience pruning and trellising

** adjusted by a factor of 6 for reduced picking efficiency and higher labour costs

*** double to represent higher packaging cost

Yukon expenses for packaging and irrigation was not determined for 2007

It should be noted that the BC fact sheet is based on a 40 acre operation which would have efficiencies not seen in a small operation and the warmer climate in BC allows for higher yields.

Realizing this difference in expenses the net income was reported in two tables to separate the two different expenses. The profit margins reported in Tables 8.3 and 8.4 is a starting point as a cost analysis, and both tables should be evaluated understanding that expenses are largely different.

Table 8.3: 2007 Yields, net income per hectare based on 3 different price levels and a modified BC expense calculation (also reported as a u-pick operation bases on BC modified expenses minus harvest cost)

						Upick operation		
	2007 Yields (kg/ha)	Projected expenses per hectare based on a modified BC factsheet	Net income per hectare @ $3.30/kg	Net income per hectare @ $6.60/kg	Net income per hectare @ $9.90/kg	Net income per acre @ $3.30/kg	Net income per acre @ $6.60/kg.	Net income per acre @ $9.90/kg
Total 2007 Harvested Average Souris Yields	1070	$7,158.98	-$3,620.60	-$82.22	$3,456.17	$2,668.38	$6,206.77	$9,745.15
Highest Yielding Souris Section	860	$6,167.13	-$3,323.97	-$480.81	$2,362.35	$1,973.16	$4,816.32	$7,659.48
Souris with row cover	1577	$9,549.61	-$4,335.55	$878.50	$6,092.56	$4,344.06	$9,558.11	$14,772.17
Average Kiska Yields	2089	$11,964.39	-$5,057.73	$1,848.93	$8,755.59	$6,036.66	$12,943.32	$19,849.98
Highest Yielding Kiska Section	2199	$12,486.96	-$5,214.01	$2,058.93	$9,331.88	$6,402.95	$13,675.90	$20,948.84
	2661	$14,665.45	-$5,865.52	$2,934.40	$11,734.33	$7,929.93	$16,729.85	$25,529.78

Table 8.4: 2007 Yields, net income per hectare based on 3 different price levels and a Yukon expenses (also reported as a u-pick operation utilizing Yukon expenses minus harvest cost)

						Upick operation		
	2007 Yields (kg/ha)	Projected expenses per hectare based on Yukon estimated expenses	Net income per hectare @ $3.30/kg	Net income per hectare @ $6.60/kg	Net income per hectare @ $9.90/kg	Net income per acre @ $3.30/kg	Net income per acre @ $6.60/kg	Net income per acre @ $9.90/kg
Total 2007 Harvested Average Souris Yields	1070	$24,225.00	-$20,686.62	-$17,148.23	-$13,609.85	-$4,636.62	-$1,098.23	$2,440.15
Highest Yielding Souris Section	860	$24,225.00	-$21,381.84	-$18,538.68	-$15,695.52	-$5,331.84	-$2,488.68	$354.48
Souris with row cover	1577	$24,225.00	-$19,010.94	-$13,796.89	-$8,582.83	-$2,960.94	$2,253.11	$7,467.17
Average Kiska Yields	2089	$24,225.00	-$17,318.34	-$10,411.68	-$3,505.02	-$1,268.34	$5,638.32	$12,544.98
Highest Yielding Kiska Section	2199	$24,225.00	-$16,952.05	-$9,679.10	-$2,406.16	-$902.05	$6,370.90	$13,643.84
	2661	$24,225.00	-$15,425.07	-$6,625.15	$2,174.78	$624.93	$9,424.85	$18,224.78

The yields are worked up from the 2007 harvest totals, averages and maximums produced for each variety and income per hectare depends largely on what the grower can achieve. Process sales market was ignored because this market is not available in the Yukon and the prices from this market ($1.50/kg or $0.70/lb) would not allow for any profits. A comparison was also conducted between incomes in a u-pick operation vs. the income for a picked and packaged (P&P) product. A P&P product sold at whole sale prices ($3.30/kg) would not create any profit, and would result in a loss to the operator. In a u-pick operation at a wholesale price some profit can be achieved under BC expenses, for example an orchard growing Kiska raspberries could achieve approximately $6,400/ha and in cases where yields can be maximized a net income of $8,000/ha may be achieved.

At whole sale prices, the 2007 orchard would have a net income of $2,700/ha with a u-pick operation using BC expenses, and the net income at $6.60/kg increases to $6,200/ha. Compare this to a P&P sold at $6.60/kg the orchard would not have a profit losing $82/ha. Under Yukon expenses, the 2007 orchard yields would not have any income, even operating as a u-pick operation. This difference is very dramatic depending on the expense cost used and also between a u-pick and P&P operation.

Teasing out the numbers in a P&P system, an operator would want to be growing Kiska raspberries at a market price of $9.90/kg. The u-pick system would likely not be able to achieve a $9.90/kg selling price, but at $6.60/kg sale price under both expense rates growing Kiska raspberries would have a profit. A more diverse operation with the production of value added products such as jams was not explored but would add some level of additional income. The Souris varieties, even with the higher yields achieved from the row cover had limited profitability compared to the Kiska raspberries.

Conclusion

The Kiska raspberries and lower expenses from the BC rates would provide an opportunity to run a profitable raspberry orchard. Using a Kiska raspberry in the orchard would direct an operation towards a u-pick setup as this type of raspberry is best suited as a berry for jam and does not have the firm fruit appearance expected from a picked and packaged berry. The row cover had a positive effect on the raspberry production and extending the use of the cover would create an opportunity to increase yields of the Souris/Boyne raspberries and provide a firmer berry for a pick and packaged market, although yields would have to be further evaluated to fully understand profitability. The irrigation system provides the orchard with the required water and fertilizer with minimal input, reducing time spent in the orchard. Based on this year's data it appears that the half fertilizer treatment works best under Yukon conditions.

Work will continue into 2008, with a focus on:

- extending the use of the row cover over 4 sections
- reducing the gap between expenses calculated using the BC data vs. expenses achieved in the trial operation
- continuing evaluation of irrigation and fertilizer

More work is also required to understand if a u-pick operation would attract pickers willing to pay $6.60/kg to pick raspberries.

Appendix

Table 1: 10 year agroclimatic data for the agricultural zones of the Yukon

		Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Whitehorse Area	Whitehorse Airport (EC)	EGDD	1102	1093	815	1002	1040	1010	1350	1194	1014	1099
		Start of growing season	04-May	16-May	04-May	16-May	01-May	27-Apr	01-May	24-Apr	19-May	18-May
		End of growing season (first killing frost -2.2°C)	30-Aug	25-Sep	02-Sep	26-Sep	17-Sep	05-Sep	06-Sep	26-Sep	30-Sep	22-Sep
		Agroclimatic capability class	Class 3	Class 3	Class 5	Class 4	Class 4	Class 4	Class 2	Class 3	Class 4	Class 3
		Number of frosts during growing season	9	4	14	10	14	22	7	17	7	6
	RF (YT)	EGDD (98-00 from research report)	956	941	771	818	693	778	1263	764	912	964
		Start of growing season				22-May	19-May	27-Apr	04-May	27-Apr	19-May	18-May
		End of growing season (first killing frost -2.2°C)	12-Aug	23-Aug	29-Aug	24-Aug	02-Aug	09-Aug	01-Sep	01-Aug	02-Sep	27-Aug
		Agroclimatic capability class	Class 4	Class 4	Class 5	Class 5	Class 5	Class 5	Class 2	Class 5	Class 4	Class 4
		Number of frosts during growing season			5	12	18	38	23	33	24	20
	Haines Junction (EC)	EGDD	916	1086	907	*	1114	805	1159	*	773	816
		Start of growing season	18-May	15-May	07-May	16-May	01-May	27-Apr	04-May	27-Apr	20-May	22-May
		End of growing season (first killing frost -2.2°C)	09-Sep	25-Sep	19-Sep	10-Sep	17-Sep	21-Aug	01-Sep	01-Sep	30-Aug	28-Aug
		Agroclimatic capability class	Class 4	Class 3	Class 4		Class 3	Class 5	Class 3		Class 5	Class 5
		Number of frosts during growing season	13	15	15		16	38	19		18	12
						*incomplete data				*incomplete data		
Southern Yukon	Watson Lake Airport (EC)	EGDD	1328	1153	993	1090	1057	1100	1332	1197	1103	1171
		Start of growing season	04-May	20-May	10-May	22-May	13-May	12-May	29-Apr	23-Apr	19-May	17-May
		End of growing season (first killing frost -2.2°C)	17-Sep	27-Sep	30-Sep	28-Sep	23-Sep	15-Sep	08-Sep	26-Sep	15-Sep	30-Sep
		Agroclimatic capability class	Class 2	Class 3	Class 4	Class 3	Class 3	Class 3	Class 2	Class 3	Class 3	Class 3
		Number of frosts during growing season	9	3	14	4	5	8	12	15	1	9

Table 1: 10 year agroclimatic data for the agricultural zones of the Yukon continued

		Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Central Yukon	Pelly Farms (YTG & EC)	Sum EGDD:	1214***	1248***	991***	1122***	1125***	1162***	1419***		1208	1529
		Start of growing season:	01-May	12-May	07-May	17-May	11-May	27-Apr	29-Apr		06-May	26-Apr
		End of growing season (first killing frost -2.2°C)	19-Aug	11-Sep	01-Sep	09-Sep	16-Sep	14-Sep	05-Sep	09-Sep	22-Aug	22-Sep
		Agroclimatic capability class	Class 2	Class 2	Class 4	Class 3	Class 3	Class 3	Class 1		Class 2	Class 1
		Number of frosts during growing season	8	14	15	6	10	29	10		14	23
			*** Used daily mean temperatures (min+max)/2									
	Mayo Airport (EC)	EGDD	1266	1341	1042	1184	1190	1261	1470	1395	1268	1417
		Start of growing season	03-May	21-Apr	07-May	17-May	12-May	27-Apr	02-May	24-Apr	07-May	05-May
		End of growing season (first killing frost -2.2°C)	19-Aug	27-Sep	10-Sep	10-Sep	22-Sep	14-Sep	05-Sep	27-Sep	16-Sep	22-Sep
		Agroclimatic capability class	Class 2	Class 2	Class 4	Class 3	Class 3	Class 2	Class 1	Class 2	Class 2	Class 1
		Number of frosts during growing season	7	21	12	2	9	18	12	9	13	11
	Dawson Airport (EC)	EGDD	1067	1147	931	1090	897	1116	1240	833**	1197	1348
		Start of growing season	17-May	11-May	06-May	17-May	16-May	27-Apr	14-May	26-Apr	07-May	05-May
		End of growing season (first killing frost -2.2°C)	19-Aug	06-Sep	27-Aug	09-Sep	15-Aug	11-Sep	25-Aug	21-Jul	24-Sep	21-Sep
		Agroclimatic capability class	Class 3	Class 3	Class 4	Class 3	Class 5	Class 3	Class 2	Class 5**	Class 3	Class 2
		Number of frosts during growing season	1	18	17	7	8	24	3	11	22	17
			**Removing the killing frost occurrence on July 21 would change the agroclimatic capability to Class 3.									

Table 2: Harvested values for each plot harvested at site HN

Site	Oilseed	Plot	Total Harvest of original sample (t/ha)	Total Harvest of clean seed (t/ha)	Total Oil of clean seed (t/ha)	Total Protein of clean seed (t/ha)
HN	Camelina Sativa	2	2.65	2.56	1.12	0.68
HN	Camelina Sativa	5	1.99	1.87	0.84	0.45
HN	Camelina Sativa	8	2.26	2.22	0.99	0.56
HN	Camelina Sativa	12	1.81	1.78	0.79	0.44
HN	*Linum usitatissimum* (Flax)	All Flax	0.91	0.72	0.31	0.16
HN	*Brassica napus*	4	1.55	0.35	0.17	0.08
HN	*Brassica napus*	9	0.85	0.14	0.06	0.03
HN	*Brassica napus*	14	1.07	0.22	0.10	0.05
HN	*Brassica napus*	15	0.41			
HN	*Brassica rapa* (Spirit River)	1	1.24	0.78	0.34	0.19
HN	*Brassica rapa* (Spirit River)	6	1.29	0.73	0.33	0.18
HN	*Brassica rapa* (Spirit River)	7	1.32	0.76	0.35	0.17
HN	*Brassica rapa* (Spirit River)	10	1.14	0.54	0.24	0.13

Table 3: Harvested values for each plot harvested at site RF

Site	Oilseed	Plot	Total Harvest, Tonnes per hectare	Total Harvest Clean seed tonnes per hectare	Tonnes of Oil per hectare (Clean Seed)	Total Protein of clean seed (t/ha)
RF	Camelina sativa	Low Input	0.98	0.92	0.41	0.22
RF	Camelina sativa	2	2.06	1.33	0.56	0.35
RF	Camelina sativa	6	1.49	1.36	0.60	0.32
RF	Camelina sativa	8	1.72	1.55	0.63	0.43
RF	Camelina sativa	14	1.73	1.60	0.72	0.38
RF	*Brassica napus*	4	0.59	0.13	0.05	0.03
RF	*Brassica napus*	5	0.58	0.16	0.06	0.04
RF	*Brassica napus*	10	0.83	0.14	0.05	0.03
RF	*Brassica napus*	16	1.20	0.58	0.19	0.14
RF	*Brassica rapa* (Reward)	1	1.38	0.74	0.32	0.17
RF	*Brassica rapa* (Reward)	3	1.12	0.70	0.31	0.16
RF	*Brassica rapa* (Reward)	11	Sample lost to mice			
RF	*Brassica rapa* (Reward)	13	1.91	0.36	0.16	0.08
RF	*Brassica rapa* (Spirit River)	7	0.98	0.60	0.28	0.13
RF	*Brassica rapa* (Spirit River)	9	1.61	1.24	0.65	0.21
RF	*Brassica rapa* (Spirit River)	12	2.15	1.19	0.57	0.26
RF	*Brassica rapa* (Spirit River)	15	2.24	1.78	0.86	0.37

Table4: Harvested values for each plot harvested at site SM

Site	Oilseed	Plot	Total Harvest, Tonnes per hectare	Total Harvest Clean seed tonnes per hectare	Tonnes of Oil per hectare (Clean Seed)	Total Protein of clean seed (t/ha)
SM	*Camelina sativa*	1	1.29	1.06	0.43	0.29
SM	*Camelina sativa*	5	0.76	0.66	0.27	0.18
SM	*Camelina sativa*	14	1.63	1.33	0.55	0.36
SM	*Camelina sativa*	20	2.90	2.80	1.17	0.75
SM	*Linum usitatissimum* (Flax)	9	0.83	0.63	0.25	0.16
SM	*Brassica napus*	3	1.28	0.64	0.27	0.17
SM	*Brassica napus*	4	2.04	0.47	0.21	0.12
SM	*Brassica napus*	10	0.83	0.08	0.04	0.02
SM	*Brassica napus*	13	0.98	0.14	0.06	0.03
SM	*Brassica rapa* (Reward)	2	1.51	1.04	0.45	0.25
SM	*Brassica rapa* (Reward)	6	0.52	0.27	0.12	0.07
SM	*Brassica rapa* (Reward)	11	0.68	0.35	0.16	0.08
SM	*Brassica rapa* (Reward)	19	0.90	0.47	0.21	0.11
SM	*Brassica rapa* (Spirit River)	7	1.09	0.58	0.26	0.14
SM	*Brassica rapa* (Spirit River)	8	1.10	0.62	0.30	0.14
SM	*Brassica rapa* (Spirit River)	12	1.32	0.61	0.29	0.15
SM	*Brassica rapa* (Spirit River)	15	0.77	0.24	0.11	0.06

Diagram 1: Raspberry plot with irrigation distribution and plant variety